



## Performance of apricot (*Prunus armeniaca*) genotypes for growth, yield and quality parameters in temperate ecosystem of Himachal Pradesh

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### ABSTRACT

Studies were carried out to assess the performance of fifteen apricot (*Prunus armeniaca* L.) genotypes for growth, yield and quality characters in temperate region of Himachal Pradesh. Based on observations during 2013 to 2016 at ICAR-Indian Agricultural Research Institute, Regional Station, Shimla tree height varied from 2.16-5.75 m, tree girth varied from 30.5-98.5 cm with maximum in Charmagaz (98.5 cm) and minimum in Nugget (30.5 cm). Canopy spread in East-West direction varied from 2.13-7.0 m with the maximum in Charmagaz (7.0m) and minimum in Harcot (2.13m). Canopy spread in North-South direction was also maximum in Charmagaz (6.80m). Plant dormancy varies from 129-154 days in different genotypes of apricot. Highest fruit set was recorded in EC-168342 (46.32%) and minimum found in Harcot (11.78%). The fruit weight was maximum in EC-168342 (86.56 g) and minimum in Nugget (20.07 g). Pulp weight was also recorded maximum in EC-168342 (82.44 g) and minimum in Nugget (17.74 g). Fruit size (L×B) was highest in EC-168342 (5.39 cm × 5.16 cm). The stone weight in different genotypes varied from 2.33-4.52g with maximum in EC-232328 (4.52g) and minimum in Nugget (2.33g). Fruit yield varied from 5.31-26.13 t/ha with maximum in EC-168342 (26.13 t/ha) and minimum in Nugget (5.31 t/ha). Dry matter content varied from 18.01%- 26.66% with maximum in New Castle (26.66%). Pulp thickness was recorded maximum in Suffaida Oblonga (12.2 mm) and minimum observed in New Castle (6.32 mm). Total soluble solids (TSS) was recorded maximum in Charmagaz (18.31%) and minimum in Harcot (12.83%). Acidity in fruit was recorded highest in EC-168342 (2.01%) and minimum in Nari Kinnaur (0.98%). The highest reducing sugar was observed in Nari Kinnaur (7.21%) with minimum was recorded in EC-232328 (3.16%). Non-reducing sugar varied from 4.52%-9.24% with maximum in Castle (9.24%). Vitamin-C content was significantly higher in EC-168342 (17.16 mg/100 g) and minimum in Shipley Early (11.98 mg/100 g).

**Key words:** Apricot, Flowering, Genotypes, Growth, Performance, Quality, Yield.

Apricot (*Prunus armeniaca* L.) an attractive, delicious and highly nutritious fruit being cultivated in temperate climate. It is rich source of beta carotenoids, antioxidant, minerals (Wills *et al.* 1983). It is native to central and western China. Globally, Turkey, Spain, Greece and France are major producers of apricot (Ghorpade *et al.* 1995). In India, apricot is mainly cultivated in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, and to a limited extent in North-eastern hills. It is good source of vitamin A, C, fiber, minerals. Apricot can be successfully grown at an altitude between 900-3000 m above mean sea level Average summer temperature (16.6°-32.2°C) is suitable for growth and better quality fruit production. Most of the genotypes start flower

bud differentiation in February-March and flowering from late March to early April depending on climatic condition. Flowering varies within the cultivar depending on prevailing weather conditions. The apricot fruit has double sigmoidal growth pattern, having a retarded growth period at the time of pit hardening (Salunkhe *et al.* 1968). In addition to consumed as fresh, apricots are processed as dried apricot, frozen products, jams, jelly, nectars and extrusion products (Singh *et al.* 2016). Moreover, apricot kernel is used in production of oil, benzydehyde, cosmetic activity, carbon and aroma perfume (Yildiz 1994). The yield and quality of apricot is appreciably affected by stage of maturity at which fruits are harvested. Apricot fruits develop maximum flavour and are very delicious when ripened on the tree but such fruits cannot be transported to distant markets because of their perishable nature. Fruits harvested sufficiently in advance of ripening do not attain full taste. Productivity of apricot is low because most of orchards are either seedling origin or lack of suitable varieties for the region. So far as limited information is available about varietal suitability

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and performance of apricot based on field experimentation in mid hill region of Himachal Pradesh. Main objective of the study was to find out suitability of apricot genotypes/varieties for mid hill region of Himachal Pradesh. Keeping this in view the present investigation was carried out to assess the performance of different genotypes under temperate ecosystem of Himachal Pradesh.

## MATERIALS AND METHODS

The study was conducted at the Horticultural Research Farm (altitude 1950 m mean seal level) of ICAR-Indian Agricultural Research Institute, Regional Station, Shimla. The experimental trees (15 years old) of fifteen genotypes, viz. Cneff-A, Baiti, Harcot, EC-168342, Suffaida Oblonga, St. Ambroise, New Castle, Kaisha, Charmagaz, Shipely Early, Nugget, Nari Kinnaur, EC-232328, Kaisha Kinnaur, Charmagaz Kinnaur with uniform age, vigour were selected. The uniform management practices with respect to agro-technique including nutrient management, training, pruning etc were adopted for all the genotypes. Apricot genotypes (grafted on wild apricot seedling as rootstock) established in the field at 4m apart under square system of planting. To assess the vigour of different genotypes the growth parameters, like plant height, canopy spread, tree girth, yield attributing parameters, like fruit length, breadth, fruit weight and fruit yield/tree, quality pulp thickness, dry matter, acidity, TSS and reducing and non-reducing sugar were recorded during 2013 to 2016 and presented based on pooled data. At the time of fruit harvest thirty fruits from each plant collected randomly and were brought to laboratory in polythene bags for analysis. Fruit size was recorded with the help of vernier calliper. TSS was determined with the help of hand refractometer. Titrable acidity was estimated against N/10 NaOH. Reducing and non-reducing sugar were estimated as per the standard procedure (AOAC 1998). The soil was gravely with low fertility status and poor water holding capacity. Single tree of each cultivar constituted an experimental unit and each genotype was replicated four times. The agroecological region comes under temperate ecosystem where experimentation was done. The soil is sandy loam mixed gravel with low fertility status and poor water-holding capacity having around 2 m soil depth. The data on various parameters were analyzed by SAS statistical package in randomized block design

## RESULTS AND DISCUSSION

### *Growth, flowering and fruit set*

Pooled data pertains to growth, flowering and fruit set behaviour of different genotypes under uniform management situation presented in Table 1. Data pertaining to plant height (Table 1) revealed that it was maximum in Suffaida Oblonga (5.75m) followed by Charmagaz (5.60 m), Kaisha Kinnaur (5.38m) with minimum in Harcot (2.13m), while plant height of other genotypes were in between. Tree girth varied from 30.5-98.5cm with maximum in Charmagaz (98.5 cm) and minimum in Nugget (30.5 cm). Canopy spread in East-West

direction varied from 2.13 m - 7.0m with the maximum in Charmagaz (7.0m) followed by in Suffaida Oblonga (5.55m), Kaisha Kinnaur (5.53m) and minimum was recorded in Harcot (2.13m). Canopy spread in North-South direction was also maximum in Charmagaz (6.80m) and minimum in Harcot (2.26m) rest were in between. Variation in tree growth in different genotypes may be attributed to genetic feature of individual variety in fruit crops (Pathak 2003 in aonla and Shukla 2016 in Peach). Plant dormancy (winter) is unique feature in temperate fruits and it varies from 129-154 days in different genotypes of apricot with maximum in Charmagaz (154days) and minimum in Shipley Early (129 days). After completion of dormancy new bud initiation takes place and it starts from 8 March to 20 March in different genotypes depending on climatic conditions. Days taken from bud initiation to flowering period in apricot depends on weather conditions however, Harcot took maximum days (20) and minimum period was recorded with Shipley Early (10) which is closely followed by Kaisha Kinnaur, St. Ambroise, Charmagaz Kinnaur (11days in each). Days taken from flowering to fruit set was varied from 4-9 with maximum in Cneff-A (9 days) and minimum in Suffaida Oblonga, New Castle, Shipley Early, Nugget (4 days in each genotypes). Highest fruit set was recorded in EC-168342 (46.32%) followed by EC-232328 (39.58%), Charmagaz (31.84%) and minimum found in Harcot (11.78%). Variation in flowering and fruit set behaviour is greatly influenced by overall climatic factor and rainfall pattern. Rodrigo and Herrero (2002) also observed the influence of temperatures on flowering and fruit set in apricot.

### *Yield attributing traits*

Data on yield attributing traits, viz. number of fruit/cluster, fruit weight, pulp content, fruit size, yield, stone characters etc was recorded and presented in Table 1 and 2. Number of fruits per cluster was significantly higher in EC-168342 (5-7) with minimum in Baiti and Nugget (1-2). The fruit weight was maximum in EC-168342 (86.56 g) followed by EC 232328 (71.23 g), Harcot (52.65g) and minimum in Nugget (20.07 g). Pulp weight was also recorded maximum in EC-168342 (82.44 g) followed by EC 232328 (66.71 g), Harcot (48.22g), St. Ambroise (42.08 g) and minimum in Nugget (17.74 g). Padder *et al* (2017) also found variation in fruit weight in different genotypes of apricot. The data presented in Table 2 indicated that fruit length was maximum in EC-168342 (5.39 cm) followed by EC-232328 (5.03 cm) and New Castle (4.83 cm) where as minimum was found in Nari Kinnaur (3.01 cm). The highest fruit width was recorded in EC168342 (5.16 cm) with lowest in Nari Kinnaur (2.82 cm) rest were in between these two. Stone length varied from 17.1-31.97 mm with maximum in EC-168342 (31.97 mm) and minimum in Nugget (17.10 mm). Similarly, stone width was highest in EC-168342 (13.14 mm) followed by EC-232328 (13.01) Kaisha (12.56 mm), whereas minimum recorded in Nugget (9.15 mm). The stone weight in different genotypes varied from 2.33-4.52g with maximum in EC-232328 (4.52g) and minimum

Table 1 Performance of apricot genotypes/varieties for tree growth, flowering and fruit set

| Germplasm         | Plant height (m) | Tree girth (cm) | Canopy spread (m) |      | Dormancy period (days) | Date of bud burst (bud initiation) | Days taken from bud burst to flowering | Days taken from flowering to fruit set | Fruit set (%) | No. of fruit/ cluster | Fruit weight (g) | Pulp weight (g) | Fruit length (cm) | Fruit width (cm) |
|-------------------|------------------|-----------------|-------------------|------|------------------------|------------------------------------|--|--|---------------|-----------------------|------------------|-----------------|-------------------|------------------|
|                   |                  |                 | E-W               | N-S  |                        |                                    |  |  |               |                       |                  |                 |                   |                  |
| EC 168342         | 5.00             | 64.00           | 4.70              | 4.37 | 151                    | 18 <sup>th</sup> March             | 16                                     | 5                                      | 46.32         | 5-7                   | 86.56            | 82.44           | 5.39              | 5.16             |
| Suffaida Oblonga  | 5.75             | 88.00           | 5.55              | 6.00 | 145                    | 15 <sup>th</sup> March             | 12                                     | 4                                      | 25.6          | 3-5                   | 42.16            | 38.92           | 3.78              | 3.45             |
| St. Ambroise      | 3.73             | 62.67           | 3.87              | 4.27 | 140                    | 18 <sup>th</sup> March             | 11                                     | 5                                      | 22.31         | 2-4                   | 45.86            | 42.08           | 4.12              | 3.72             |
| New Castle        | 3.35             | 41.50           | 3.45              | 2.90 | 138                    | 08 <sup>th</sup> March             | 17                                     | 4                                      | 20.92         | 2-3                   | 38.21            | 34.55           | 4.83              | 4.33             |
| Kaisha            | 3.35             | 56.50           | 4.00              | 3.25 | 149                    | 9 <sup>th</sup> March              | 14                                     | 5                                      | 27.85         | 2-3                   | 33.86            | 30.47           | 3.65              | 3.35             |
| Charmagaz         | 5.60             | 98.50           | 7.00              | 6.80 | 154                    | 20 <sup>th</sup> March             | 12                                     | 5                                      | 31.84         | 3-5                   | 34.8             | 30.51           | 3.64              | 3.27             |
| Shipely Early     | 4.08             | 50.50           | 3.60              | 3.60 | 129                    | 8 <sup>th</sup> March              | 10                                     | 4                                      | 19.88         | 2-4                   | 38.26            | 33.94           | 3.59              | 3.01             |
| Nugget            | 2.50             | 30.50           | 2.25              | 2.45 | 142                    | 18 <sup>th</sup> March             | 15                                     | 4                                      | 21.46         | 1-2                   | 20.07            | 17.74           | 3.66              | 2.97             |
| Nari Kinnaur      | 4.23             | 44.00           | 3.27              | 2.80 | 146                    | 18 <sup>th</sup> March             | 13                                     | 6                                      | 26.58         | 3-5                   | 28.65            | 35.41           | 3.01              | 2.82             |
| EC-232328         | 3.97             | 44.00           | 3.60              | 3.10 | 152                    | 15 <sup>th</sup> March             | 14                                     | 7                                      | 39.58         | 5-6                   | 71.23            | 66.71           | 5.03              | 4.78             |
| Kaisha Kinnaur    | 5.38             | 77.50           | 5.53              | 6.48 | 129                    | 15 <sup>th</sup> March             | 12                                     | 6                                      | 27.41         | 3-4                   | 39.89            | 36.68           | 3.61              | 3.12             |
| Charmagaz Kinnaur | 5.08             | 58.75           | 4.75              | 4.53 | 134                    | 16 <sup>th</sup> March             | 11                                     | 8                                      | 21.52         | 2-4                   | 41.21            | 37.43           | 3.55              | 3.15             |
| Cneff-A           | 2.75             | 53.63           | 2.65              | 2.73 | 150                    | 16 <sup>th</sup> March             | 18                                     | 9                                      | 18.32         | 3-4                   | 34.84            | 30.72           | 3.41              | 3.15             |
| Baiti             | 3.10             | 44.81           | 2.96              | 3.12 | 141                    | 18 <sup>th</sup> March             | 16                                     | 7                                      | 13.81         | 1-2                   | 41.12            | 36.80           | 3.62              | 3.59             |
| Harcot            | 2.16             | 36.59           | 2.13              | 2.26 | 148                    | 14 <sup>th</sup> March             | 20                                     | 8                                      | 11.78         | 2-3                   | 52.65            | 48.22           | 4.14              | 4.13             |
| CD (P=0.05)       | 0.962            | 2.23            | 1.01              | 1.33 | 1.89                   |                                    | 0.34                                   | 0.11                                   | 3.65          |                       | 3.42             | 2.11            | 0.16              | 0.15             |

in Nugget (2.33g). Pulp/stone ratio was recorded maximum in EC-168342 (20) followed by EC-232328 (14.76), Harcot (11.88), whereas minimum was noted in Charmagaz (7.46). Fruit yield (t/ha) in different genotypes varied from 5.31-26.13 t/ha with maximum in EC-168342 (26.13 t/ha) and minimum in Nugget (5.31 t/ha) rest were in between. Fruit yield is one of the most important parameters that indicate the potentiality of particular genotype. In addition, edapho-climatic condition such as fulfilment of chilling requirement, rainfall, cardinal temperature were also play key role during fruit set and fruit growth period and it may have direct effect on fruit yield in genotypes of apricot. Similar finding was also reported by Kumar *et al* (2016). Crop load (yield) in apricot is greatly affected by climate due to increased fruit set as reported by Rodrigo and Herrero (2002). The fruit yield/tree may also be influenced with plant having higher fruit set, number of fruit/cluster, fruit size and tree canopy (Shukla *et al.* 2015). Saroj *et al.* (2008) in bael, Shukla *et*

*al.* (2009) in aonla, Bhat *et al.* (2013) in apricot have also observed similar results.

#### Quality parameters

Data presented in Table 2 indicated that dry matter content varied from 18.01%- 26.66% with significantly higher in New Castle (26.66%) and lowest in Cneff-A (18.01). In temperate ecosystem apricot grown in rainfed condition may tended to more accumulation of dry matter in mature fruits this finding is in line with result reported by Shukla *et al* (2009) in aonla. Pulp thickness has positive correlation with quantity of pulp and varietal suitability for dehydration and higher thickness was recorded in Suffaida Oblonga (12.2 mm) closely followed by EC-168342 (11.8 mm), Charmagaz (10.51 mm), Harcot (9.45 mm), whereas minimum observed in New Castle (6.32 mm). Total soluble solids (TSS) is an important quality trait in apricot which directly influenced the taste of ripe fruits. In Charmagaz

Table 2 Variability in apricot genotypes for yield and quality parameters

| Germplasm         | Stone length (cm) | Stone width (cm) | Stone weight (g) | Stone/pulp ratio | Yield (t/ha) | Dry matter content (%) | Pulp thickness (mm) | TSS (%) | Acidity (%) | TSS/ acidity ratio | Reducing sugar (%) | Non reducing sugar (%) | Vitamin-C (mg/100g) |
|-------------------|-------------------|------------------|------------------|------------------|--------------|------------------------|---------------------|---------|-------------|--------------------|--------------------|------------------------|---------------------|
| E.C 168342        | 31.97             | 13.14            | 4.12             | 20.00            | 26.13        | 20.45                  | 11.8                | 13.01   | 2.01        | 5.96               | 3.95               | 4.56                   | 17.16               |
| Suffaida Oblonga  | 18.54             | 10.45            | 3.24             | 12.01            | 10.49        | 20.75                  | 12.2                | 15.12   | 1.23        | 12.29              | 6.59               | 9.12                   | 12.94               |
| St. Ambroise      | 20.75             | 12.25            | 3.78             | 11.13            | 7.72         | 21.44                  | 9.12                | 15.84   | 1.36        | 11.65              | 6.23               | 6.99                   | 16.08               |
| New Castle        | 17.15             | 11.83            | 3.66             | 9.44             | 12.57        | 26.66                  | 6.32                | 13.80   | 1.48        | 9.32               | 6.31               | 9.24                   | 13.98               |
| Kaisha            | 22.34             | 12.56            | 3.39             | 8.99             | 20.11        | 19.75                  | 7.86                | 14.10   | 1.43        | 9.86               | 5.71               | 7.20                   | 15.39               |
| Charmagaz         | 19.21             | 12.25            | 4.29             | 7.11             | 9.80         | 24.97                  | 10.51               | 18.31   | 1.51        | 10.14              | 5.22               | 7.85                   | 12.67               |
| Shipely Early     | 17.65             | 9.98             | 4.32             | 7.86             | 9.46         | 23.79                  | 8.62                | 15.23   | 1.35        | 11.28              | 6.40               | 8.12                   | 11.98               |
| Nugget            | 17.10             | 9.15             | 2.33             | 7.61             | 5.31         | 22.75                  | 7.91                | 14.11   | 1.12        | 12.59              | 4.73               | 7.54                   | 12.94               |
| Nari Kinnaur      | 18.75             | 10.28            | 3.24             | 10.93            | 15.85        | 21.89                  | 8.46                | 17.21   | 0.98        | 17.56              | 6.15               | 8.01                   | 13.99               |
| EC-232328         | 24.32             | 13.01            | 4.52             | 14.76            | 12.61        | 20.95                  | 7.98                | 15.68   | 1.98        | 7.92               | 3.16               | 4.52                   | 15.88               |
| Kaisha Kinnaur    | 21.54             | 11.58            | 3.21             | 11.43            | 14.51        | 19.96                  | 8.12                | 17.16   | 1.08        | 15.89              | 7.21               | 6.89                   | 15.09               |
| Charmagaz Kinnaur | 20.65             | 12.31            | 3.78             | 9.90             | 9.10         | 21.98                  | 9.01                | 15.98   | 1.11        | 14.39              | 6.53               | 7.01                   | 13.48               |
| Cneff-A           | 23.82             | 11.34            | 4.12             | 7.46             | 8.51         | 18.01                  | 8.42                | 13.83   | 1.12        | 12.35              | 5.67               | 6.25                   | 14.01               |
| Baiti             | 22.23             | 11.07            | 4.32             | 8.52             | 10.84        | 18.87                  | 8.89                | 14.20   | 1.01        | 14.06              | 6.25               | 6.75                   | 13.45               |
| Harcot            | 22.86             | 12.39            | 4.43             | 11.88            | 6.66         | 18.78                  | 9.45                | 12.83   | 1.32        | 9.72               | 4.93               | 5.93                   | 14.45               |
| CD (P=0.05)       | 0.15              | 0.11             | 0.11             | 2.31             | 1.89         | 0.19                   | 0.12                | 0.10    | NS          |                    | 0.22               | 0.32                   | 0.10                |

maximum TSS (18.31%) was recorded which was followed by Nari Kinnaur (17.21%), Kaisha Kinnaur (17.16%) and minimum in Harcot (12.83%). Acidity in fruit was recorded highest in EC-168342 (2.01%) and minimum in Nari Kinnaur (0.98%) rest were in between. TSS/acidity ratio varied from 5.96-17.56 with maximum in Kaisha Kinnaur (17.56) and minimum in EC-168342 (5.96). Variations in TSS and acidity in different genotypes was also reported by Raj *et al.* (2015) in apricot. The highest reducing sugar was observed in Nari Kinnaur (7.21%) followed by Suffaida Oblonga (6.59%), Shipley Early (6.40%), New Castle (6.31%) however, minimum was recorded in EC-232328 (3.16%). Non-reducing sugar varied from 4.52%-9.24% with maximum in Castle (9.24%) and minimum in EC-232328 (4.52%) rest were in between. Genotypic variation in quality traits were also reported by Sharma *et al.* (2004) and Sharma *et al.* (2005). It is apparent from data (Table 2) that Vitamin-C content was significantly higher in EC-168342 (17.16 mg/100g) closely followed by St. Ambroise (16.08 mg/100 g), EC-232328 (15.88 mg/100 g), whereas minimum was recorded in Shipley Early (11.98mg/100g), this result is in line with findings reported by Sharma *et al.* (2005) and Bhat *et al.* (2013). Variation in quality characters in different genotypes may

be attributed to genetic feature of individual variety and along with agrotechnique management. The fruit yield/tree increases with the increasing age and canopy of the plant upto certain stage Shukla *et al.* 2015 also reported similar variations in these characteristics in Chinese gooseberry.

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