



## EVALUATION OF SOME SCAB RESISTANT APPLE HYBRIDS AS EARLY SEASON GENOTYPES

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(Received 22 September, 2013; accepted 28 June, 2014)

### ABSTRACT

Five scab-resistant hybrids [ASPE-99 (Sunhari x Prima), ASPE-36 (Lal Ambri x Prima), ALPE-99 (Sunhari x Prima), ASPE-22 (Sunhari x Prima) and ALPE-57 (Lal Ambri x Prima)] developed by SKUAST-Kashmir, were evaluated for phenological, pomological and storage characteristics in 2009 and 2010. The days taken to full bloom ranged between 80.5 to 86.5 in hybrids and 76.5 to 83.0 in check cultivars. ASPE-36 and ASPE-99 matured earlier (82 days for fruit development) while ALPE-57, ASPE-22 and ALPE-99 matured 6.0-16.5 days later. Fruit shape in hybrids was oblate and slight to moderately lopsided with smooth surface. Fruits were crisp, juicy, moderately flavoured and red coloured with yellowish background and creamy flesh. Fruit firmness was maximum in ALPE-57 followed by ALPE-99 and ASPE-36. Hybrids significantly varied in fruit size and weight with high values in ALPE-99, ALPE-57 and ASPE-22. Hybrids had higher TSS and total sugars and were less acidic than checks. Total sugar was maximum and titrable acidity minimum in ASPE-22. The storage life of hybrids was higher than control with maximum storage life of 156-172 days under CA storage, 73-88 days under refrigeration and 34-45 days under normal storage conditions. Hybrids ASPE-99, ASPE-22 and ALPE-57 were identified as prospective genotypes for release as improved early season scab-resistant cultivars.

**Key words:** Apple hybrids, flower phenology, fruit characteristics, scab resistant

### INTRODUCTION

Apple is produced in the countries which possess cool temperate climate. Global apple production is dominated by China followed by USA, France, Turkey and Italy. In India apple cultivation is confined to Jammu & Kashmir (64.1%), Himachal Pradesh (30.9%), Uttaranchal Pradesh (4.7%) and Arunachal Pradesh (0.3%) on an area of 2.891 lakh ha with a fruit production of 28.91 lakh tonnes (Anonymous, 2011a). Apple is the main fruit crop of Jammu & Kashmir state grown on 1.42 lakh ha area with annual production of 18.52 lakh tonnes (Anonymous, 2011b).

The apple industry in J&K State is currently experiencing a period of transition where new and locally adapted apple cultivars possessing good keeping quality and competitiveness in local and outside markets are increasingly required to ensure better economic gains. For a cultivar to be recommended for planting, the fruit must be of acceptable quality. The components of food product

quality are sensory attributes (appearance, texture, taste and odour), nutritional value, chemical components, mechanical and functional features and lack of defects (Abbott, 1999). The evaluation and identification of promising apple varieties with good marketing potential has been the focus of researchers. In Kashmir some high quality and high yielding apple cultivars ('Lal Ambri, Sunhari', 'Akbar' and 'Shalimar Apple-2') and good quality scab resistant cultivars ('Firdous', 'Shireen' and 'Shalimar Apple-1') have been developed which have immensely benefited the apple industry (Banday and Sharma, 2010). However, the lack of high quality disease resistant early season apple varieties is a major concern in the Western Himalayan states. The traditionally grown early season apple cultivars are shy-bearing, sub-acidic and susceptible to scab with poor shelf life. Exotic early season apple varieties 'Vistabella' and 'Gala Must', though better in quality, have also poor shelf life and are mediocre in yield and susceptible to scab disease. For regulating market by enhancing the availability spectrum of apple, improved early season scab resistant apples are desired which can fetch better remuneration to growers. After several years of rigorous screening and evaluation against various pests and diseases, particularly scab, apple hybrids were evolved through hybridization among commercially grown cultivars and scab resistant cultivar 'Prima' at Shalimar (Kashmir). These hybrids started bearing fruits in 2007 after 15 years gestation. The fruits of these hybrids matured earlier than the known early season apple cultivars grown in the state as well as were scab resistant. The present study was aimed to evaluate these scab resistant hybrids for various phenological, pomological and storage characteristics before recommending them for commercial cultivation as good quality early seasoned scab resistant apple cultivars under Kashmir conditions.

## MATERIALS AND METHODS

The present study was undertaken on five scab resistant apple hybrids *viz.*, ASPE-99 (Sunhari x Prima), ASPE-36 (Lal Ambri x Prima), ALPE-99 (Sunhari x Prima), ASPE-22 (Sunhari x Prima) and ALPE-57 (Lal Ambri x Prima), developed at Research Farm of the Division of Fruit Science, SKUAST-Kashmir, Shalimar, during 2009-2011. These hybrids after passing through 15 years of long gestation period commenced bearing in 2007. The hybrids were evaluated for various physico-chemical characteristics of fruits during fruiting season of 2009 and 2010 using three early seasoned apple cultivars ('Benoni', 'Irish Peach', 'American Mother') as check. A representative sample of 10 fruits was taken from each tree (in replicate). The fruit shape, surface and symmetry were evaluated as per descriptor of apple (Watkins and Smith, 1982). Four point hedonic scale was used for evaluation of fruit crispness (with 1 = low crispness, 2 = moderate crispness, 3 = high crispness, 4 = very high crispness), juiciness (with 1 = low juice content, 2 = medium juice content, 3 = high juice content, 4 = very high juice content) and flavour (with 1 = low flavour, 2 = moderate flavour, 3 = high flavour, and 4 = very high flavour). A sample of 5 fruits of each genotype was independently evaluated by five judges having fair knowledge of fruit evaluation. The criteria for designation of hybrids and cultivars on the basis of average scores was <1.5 (low flavour, low crispness and low juiciness), 1.5-2.5 (moderate flavour, moderate crispness and moderate juiciness), 2.5-3.5 (high flavour, high crispness and high juiciness) and  $\geq 3.5$  (very high flavour, very high crispness and very high juiciness). Royal Horticultural Society's colour chart was used for the evaluation of colour characteristics of fruit. Fruit firmness was measured by a hand penetrometer. Measurements were taken twice on each fruit on its opposite sides. Fruit size was measured with the help of a Vernier caliper and fruit weight by a digital balance. Total soluble solids in fruit juice was determined with the help of a hand refractometer and titrable acidity as per Ranganna (2001) and total sugar, in term of per cent maleic acid as per Lane and Eynon's method (Ranganna, 2001).

The shelf life of fruits was assessed under 3 environments *viz.*, refrigerated, controlled atmosphere (CA) and normal storage conditions. Under refrigerated conditions, the fruits were kept

in a refrigerator at  $4\pm1^{\circ}\text{C}$  for 90 days and fruit conditions monitored at 5 days interval for skin shrinkage and wrinkle development. Under CA storage conditions, the fruits were packed in small cardboard boxes and kept in controlled atmospheric storage chamber for 6 months and fruit condition monitored at 15 days interval. The CA storage chamber was maintained at  $4^{\circ}\text{C}$  with 2%  $\text{CO}_2$  and 3%  $\text{O}_2$ . Another set of fruits was kept under normal conditions in a growth chamber at  $20\pm1^{\circ}\text{C}$  and fruits observed at 3 days interval. All the experiments were conducted in a completely randomized design with a sample size of 30 fruits per replication. The data was analyzed using Minitab statistical package and means compared using least significant difference test.

## RESULTS AND DISCUSSION

### *Flowering behaviour and fruit maturity*

Synchronization of flowering of cross compatible cultivars is vital for higher fruit set. Date of full bloom during 2009 and 2010, respectively, was 22-29 and 21-29 April in hybrids and 17-26 and 17-23 April in check cultivars. The mean days to full bloom from reference date (31<sup>st</sup> January) ranged from 80.5 to 86.5 in hybrids and 76.5 to 83 in check cultivars. Flowers remained open on trees for 8 to 9 days in check cultivars and 8.5 to 10.5 days in hybrids, thereby providing more time for cross pollination and better fruit set in hybrids (Table 1). The apple cultivars that ripen at different times are required to extend the picking season and market period. In present study, the date of harvest ranged from 14 to 28 July in hybrids, except ALPE-99, and 19 July to 13 August in check cultivars in both the years. Fruit development period ranged from 81.0 to 98.5 days in hybrids and 92.5 to 108 days in check. Earliest harvest was in ASPE-36, ASPE-99, ALPE-57 and ASPE-22 with fruit development period of 81, 83, 88 and 92.5 days, respectively. Synchronization of flowering of hybrids with the established early maturing check cultivars and fruit maturity data recorded during the study period support the fact that hybrids can be categorized as early season selections. Guleryuz (1995) and Asma *et al.* (2007) used ripening and harvest dates as indices for the characterization of cultivars as early or late season groups.

### *Physical characteristics of fruits*

The fruit must be of acceptable quality for a cultivar to be recommended for planting. The shape, size and colour of fruit have remarkable effect on sales. In apple, any shape from flat oblate to tall conic are acceptable and fruit shape has not been subjected to great selective pressure. In present study, apple hybrids viz., ASPE-99, ALPE-99, ASPE-22 and ALPE-57 produced flat rounded (oblate) fruits but ASPE-36 had round shaped fruit (Table 2; Plate 1). Slight variation was observed among the hybrids in fruit symmetry and surface with ASPE-99 and ALPE-57 slightly lopsided and ASPE-36 and ASPE-22 moderately lopsided. All the hybrids had a smooth fruit surface, except ASPE-22

**Table 1: Phenological characteristics of scab resistant hybrids and commercially grown early seasoned apple cultivars**

| Hybrids/<br>cultivars | Date of full<br>bloom |      | Days to full bloom<br>from 31 <sup>st</sup> Jan. |      |      | No of days flowers<br>remained open on tree |      |      | Date of<br>harvest |      | Fruit development<br>period (days) |      |       |
|-----------------------|-----------------------|------|--------------------------------------------------|------|------|---------------------------------------------|------|------|--------------------|------|------------------------------------|------|-------|
|                       | 2009                  | 2010 | 2009                                             | 2010 | Mean | 2009                                        | 2010 | Mean | 2009               | 2010 | 2009                               | 2010 | Mean  |
| ASPE-99               | 25/4                  | 22/4 | 84                                               | 81   | 82.5 | 9                                           | 10   | 9.5  | 14/7               | 17/7 | 80                                 | 86   | 83.0  |
| ASPE-36               | 29/4                  | 26/4 | 88                                               | 85   | 86.5 | 9                                           | 8    | 8.5  | 16/7               | 22/7 | 78                                 | 84   | 81.0  |
| ALPE-99               | 25/4                  | 29/4 | 84                                               | 88   | 86.0 | 7                                           | 10   | 8.5  | 04/8               | 07/8 | 101                                | 96   | 98.5  |
| ASPE-22               | 26/4                  | 22/4 | 85                                               | 81   | 83.0 | 10                                          | 11   | 10.5 | 22/7               | 28/7 | 88                                 | 97   | 92.5  |
| ALPE-57               | 22/4                  | 21/4 | 81                                               | 80   | 80.5 | 8                                           | 10   | 9.0  | 26/7               | 21/7 | 85                                 | 91   | 88.0  |
| Benoni                | 17/4                  | 23/4 | 76                                               | 82   | 79.0 | 8                                           | 10   | 9.0  | 26/7               | 30/7 | 100                                | 97   | 98.5  |
| Irish Peach           | 18/4                  | 17/4 | 77                                               | 76   | 76.5 | 7                                           | 9    | 8.0  | 20/7               | 19/7 | 93                                 | 92   | 92.5  |
| American Mother       | 26/4                  | 22/4 | 85                                               | 81   | 83.0 | 7                                           | 11   | 9.0  | 10/8               | 13/8 | 107                                | 109  | 108.0 |

**Table 2: Fruit characteristics of Scab resistant apple hybrids and commercially grown early seasoned apple cultivars**

| Hybrids/<br>cultivars | Fruit<br>Shape         | Fruit<br>symmetry       | Fruit<br>surface | Ground<br>fruit<br>color | Over<br>fruit<br>colour | Flesh<br>colour | Crisp-<br>ness     | Juici-<br>ness    | Flavour           |
|-----------------------|------------------------|-------------------------|------------------|--------------------------|-------------------------|-----------------|--------------------|-------------------|-------------------|
| ASPE-99               | Flat round<br>(oblate) | Slightly lop<br>sided   | Smooth           | Yellow                   | Red<br>stripped         | Cream           | High<br>(3.4)      | High<br>(3.4)     | Moderate<br>(2.4) |
| ASPE-36               | Round                  | Moderately<br>lop sided | Smooth           | Yellow                   | Red                     | Cream           | High<br>(3.0)      | High<br>(2.8)     | Moderate<br>(2.0) |
| ALPE-99               | Flat round<br>(oblate) | Lop sided               | Smooth           | Greenish<br>yellow       | Red                     | Cream           | High<br>(3.2)      | High<br>(3.0)     | High<br>(3.2)     |
| ASPE-22               | Flat round<br>(oblate) | Moderately<br>lop sided | Bumpy            | Yellow                   | Red                     | Cream           | High<br>(3.4)      | High<br>(3.2)     | Moderate<br>(2.2) |
| ALPE-57               | Flat round<br>(oblate) | Slightly lop<br>sided   | Smooth           | Yellow                   | Red                     | Cream           | Very High<br>(3.8) | High<br>(3.4)     | Moderate<br>(2.4) |
| Benoni                | Roundish<br>Conic      | Asymmetric              | Smooth           | Greenish<br>yellow       | Red<br>stripped         | Yellow          | High<br>(3.0)      | Moderate<br>(2.2) | Low<br>(1.2)      |
| Irish<br>Peach        | Flat round<br>(oblate) | Symmetric               | Smooth           | Yellow                   | Red<br>blush            | White           | High<br>(3.2)      | High<br>(2.8)     | Low<br>(1.0)      |
| American<br>Mother    | Roundish<br>Conic      | Slightly<br>lop sided   | Smooth           | Yellow                   | Brown                   | White           | High<br>(2.8)      | Low<br>(1.2)      | Moderate<br>(1.8) |

The data in parenthesis are mean ratings during evaluation on four point hedonic scale with <1.5 (low flavour, low crispness and low juiciness), 1.5 - 2.5 (moderate flavour, moderate crispness and moderate juiciness), 2.5 - 3.5 (high flavour, high crispness and high juiciness) and  $\geq 3.5$  (very high flavour, very high crispness and very high juiciness).

which had a bumpy surface. Market acceptance of most fruits especially apple is primarily based on colour appearance because other quality attributes such as texture and flavour etc., can't be evaluated prior to fruit consumption. All the hybrids had attractive fruit colour i.e. red or red stripped. Flesh colour varied from white through cream to pale yellow. Although there is no strong preference for a particular flesh colour but generally clear yellow or creamy ones are preferred. The flesh colour of hybrids was cream. Richard (1995) also recorded significant variation in apple fruit shape, symmetry, size and colour.

The crispness and juiciness of fruit affects the consumer acceptance. All the hybrids were fine textured, crispy and juicy with ALPE-57 proving superior in crispness. The check cultivars exhibited poor performance in these traits. Apple flavour, often difficult to judge, is dependent on a delicate balance between sugars, acids, tannins and aromatic compounds. Flavour is most difficult to analyze as more than 350 volatile compounds have been detected in apple (Maarse, 1991). All the hybrids had moderate flavour, except ALPE-99 with high flavour. The check cultivars 'Benoni' and 'Irish Peach' had low flavor while 'American Mother' had moderate flavor. The composition of volatile substances which determines the aroma/flavour depends on the cultivar (Kondo *et al.*, 2005) and cultivars generally differ significantly in this respect (Karlsen *et al.*, 1999).

**Plate 1: Scab resistant apple hybrids**

**Table 3: Fruit size, weight and firmness of scab resistant apple hybrids and commercially grown early seasoned apple cultivars**

| Hybrids/<br>cultivars | Fruit size (mm) |       |       | Fruit weight (g) |        |        | Fruit firmness (kg cm <sup>-2</sup> ) |       |       |
|-----------------------|-----------------|-------|-------|------------------|--------|--------|---------------------------------------|-------|-------|
|                       | 2009            | 2010  | Mean  | 2009             | 2010   | Mean   | 2009                                  | 2010  | Mean  |
| ASPE-99               | 69.95           | 70.11 | 70.03 | 107.26           | 118.18 | 112.72 | 13.94                                 | 14.52 | 14.23 |
| ASPE-36               | 62.55           | 72.61 | 67.58 | 94.08            | 124.24 | 109.16 | 15.32                                 | 15.90 | 15.61 |
| ALPE-99               | 82.33           | 84.35 | 83.34 | 121.71           | 152.32 | 137.01 | 15.08                                 | 16.60 | 15.84 |
| ASPE-22               | 72.55           | 69.81 | 71.18 | 114.53           | 112.23 | 113.38 | 14.90                                 | 15.74 | 15.32 |
| ALPE-57               | 83.22           | 78.27 | 80.74 | 124.96           | 140.07 | 132.51 | 18.02                                 | 19.20 | 18.61 |
| Benoni                | 62.95           | 68.72 | 65.83 | 83.22            | 107.23 | 95.22  | 11.80                                 | 12.04 | 11.92 |
| Irish Peach           | 59.97           | 66.43 | 63.20 | 76.91            | 99.56  | 88.23  | 15.20                                 | 15.44 | 15.32 |
| American Mother       | 73.48           | 77.52 | 75.50 | 116.52           | 136.28 | 126.40 | 12.70                                 | 13.10 | 12.90 |
| CD <sub>0.05</sub>    | 0.49            | 1.73  | 3.50  | 5.40             | 3.68   | 13.99  | 0.93                                  | 1.52  | 0.98  |

Fruit size is a highly variable character affected by many environmental factors including fruit set. A cultivar producing fruits of <60 mm dia. is considered undesirable for market. Significant variation was observed among the hybrids in fruit size with maximum size in ALPE-99 and ALPE-57 (mean fruit dia., 83.34 and 80.74 mm, respectively) which differed significantly from check cultivars. ASPE-22, ASPE-99 and ASPE-36 had medium size fruits [71.18, 70.03 and 67.58 mm, respectively] (Table 3). Fruit size of hybrids was superior to 'Benoni' and 'Irish Peach'. Maximum mean fruit weight of 137.1 g was found in ALPE-99, followed by ALPE-57 (132.5 g) and ASPE-22 (113.4 g) and minimum fruit weight of 88.2 and 95.2 g in 'Irish Peach' and 'Benoni'. Czynczyk *et al.* (2011) reported great variation in fruit size in scab resistant apple cultivars. Similarly, Yao *et al.* (2012) observed significant variation in apple fruit weight (110 to 250 g fruit<sup>-1</sup>) and attributed it to factors like cultivar, rootstock, crop load, fruit thinning and weather conditions. Firmness and sugar content directly affect consumers on purchasing fresh apple fruit (Asma *et al.*, 2007). Flesh firmness is highly dependent on ripeness. As ripening proceeds, tissue becomes less firm and juice is released. Non-destructive sensing of fruit for internal quality, especially firmness and sugar content, would allow the fruit industry to provide better, more consistent fruit to the consumers and thus improve industry competitiveness and profitability (Harsan *et al.*, 2006; Yankun and Renfu, 2006). Fruit firmness of hybrids was comparatively better with maximum firmness in ALPE-57 (18.61 kg cm<sup>-2</sup>), followed by ALPE-99 (15.84 kg cm<sup>-2</sup>) and ASPE-36 (15.61 kg cm<sup>-2</sup>) and minimum in check cultivars 'Benoni' and 'American Mother' (11.92 and 12.9 kg cm<sup>-2</sup>, respectively).

### **Chemical characteristics of fruit**

The hybrid fruits had higher total soluble solids content than check cultivars with highest TSS in ALPE-57 followed by ALPE-99, ASPE-99, and ASPE-22 (Table 4). The hybrid ASPE-36 with TSS of 12.20°Brix was at par with checks. Increase in TSS is one of the primary changes associated with fruit ripening. Proper balance of sugars and acids not only produces the desired sweetness but also accentuates other flavour components. A significant variation (8.05 to 12.29%) in total sugar content was observed in hybrids. Hybrids had significantly higher sugar content than check cultivars. Highest total sugar content was in ASPE-22 (12.29%), followed by ALPE-99 and ALPE-57. Low sugar content was in check cultivars (5.77 to 5.96%). The sugar content in apple differs depending on the weather conditions, cultivars, culture technology, position and exposition of fruits in crown (Mitre *et al.*, 2009; Sestras *et al.*, 2009). Acidity of hybrids ranged from 0.21 to 0.26% and varied significantly from check cultivars (0.42 to 0.44%). Lowest acidity was found in ASPE-22 and ASPE-99. All the hybrids had acidity within the maximum permissible limit of 0.31% (Campeanu *et al.*, 2009). Low acidity determines a good quality and taste for human consumption.

### **Storage life of fruits**

It is essential to maintain freshness and high fruit quality during storage (Argenta *et al.*, 2000; Zude *et al.*, 2006). Apples are produced in a narrow window (typically 3 months depending on maturity),

**Table 4: Chemical fruit characteristics of scab resistant apple hybrids and commercially grown early seasoned apple cultivars**

| Hybrids/<br>cultivars | TSS ( $^{\circ}$ Brix) |       |       | Acidity (% malic acid) |       |       | Total sugars (%) |       |       |
|-----------------------|------------------------|-------|-------|------------------------|-------|-------|------------------|-------|-------|
|                       | 2009                   | 2010  | Mean  | 2009                   | 2010  | Mean  | 2009             | 2010  | Mean  |
| ASPE-99               | 13.0                   | 13.0  | 13.00 | 0.23                   | 0.22  | 0.225 | 7.93             | 8.16  | 8.05  |
| ASPE-36               | 12.0                   | 12.4  | 12.20 | 0.23                   | 0.24  | 0.235 | 10.80            | 10.34 | 10.57 |
| ALPE-99               | 13.1                   | 13.3  | 13.20 | 0.22                   | 0.26  | 0.240 | 11.90            | 12.00 | 11.95 |
| ASPE-22               | 13.2                   | 12.6  | 12.90 | 0.22                   | 0.20  | 0.210 | 12.43            | 12.16 | 12.29 |
| ALPE-57               | 15.2                   | 14.1  | 14.65 | 0.28                   | 0.24  | 0.260 | 11.60            | 11.28 | 11.44 |
| Benoni                | 12.1                   | 12.6  | 12.35 | 0.42                   | 0.46  | 0.440 | 5.48             | 6.12  | 5.80  |
| Irish Peach           | 11.9                   | 12.1  | 12.00 | 0.40                   | 0.44  | 0.420 | 5.72             | 5.82  | 5.77  |
| American Mother       | 12.0                   | 12.3  | 12.15 | 0.40                   | 0.46  | 0.430 | 5.82             | 6.10  | 5.96  |
| CD <sub>0.05</sub>    | 0.228                  | 0.340 | 0.374 | 0.025                  | 0.056 | 0.036 | 0.232            | 0.08  | 0.244 |

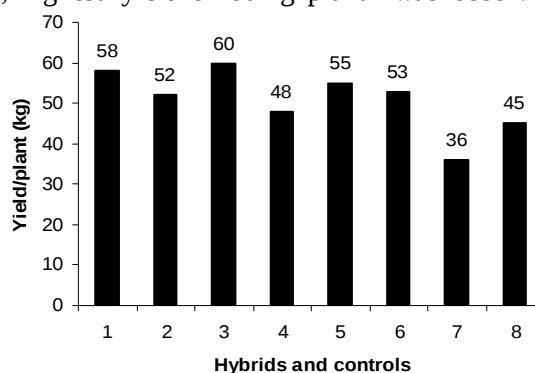
but consumed round the year, therefore, fruits of a cultivar with long shelf life are preferred. Cultivars with good storage life and keeping quality are generally kept in cold store and marketed in off season to fetch high prices. Hybrids as compared to check cultivars showed superior storage performance under all the three storage conditions tested. Under controlled atmospheric storage, highest shelf life of 172 days was observed in ASPE-99 but was at par with ASPE-22 (169 days). Both hybrids had significantly higher shelf life than other hybrids and check cultivars. Other hybrids also differed significantly from 'Irish Peach' and 'Benoni'. Under refrigeration conditions, all the hybrids differed significantly from check cultivars with respect to storage life. Maximum storage life of 88 days in ASPE-22 was at par with 86 days in ASPE-99 but both differed significantly from ASPE-36 and ALPE-57. Minimum storage life was in 'American Mother' and 'Benoni'. Under normal storage conditions at 20°C, maximum storage life was observed in ASPE-99 and ALPE-57 (45 days) which were at par with ASPE-22 (42 days). All the hybrids differed significantly from checks, which showed storage life of 22 days ('American Mother' and 'Benoni') and 28 days (Irish Peach). Storage life varies with the cultivar. Proper choice of cultivar is essential for long-term storage. Some apple cultivars are excellent keepers, while others have a short storage life even with good storage conditions (Hirst *et al.*, 2006).

### ***Yield potential and productivity***

Productivity has become increasingly important because production costs continue to rise and the financial returns to grower decline. It is, therefore, important that new cultivars should be high yielder and regular bearer throughout the life of orchard. Productivity of hybrids was superior to checks with average yield of hybrids being higher (64.60 kg plant<sup>-1</sup>) than the average yield of check cultivars (44.67 kg plant<sup>-1</sup>). Among the hybrids, highest yield of 60 kg plant<sup>-1</sup> was observed in

**Table 5: Storage life of scab resistant apple hybrids and commercially grown early seasoned apple cultivars**

| Hybrids/<br>cultivars | Storage life (days) |                         |                   |
|-----------------------|---------------------|-------------------------|-------------------|
|                       | C.A<br>storage      | Refrigerated<br>storage | Normal<br>storage |
| ASPE-99               | 172                 | 86                      | 45                |
| ASPE-36               | 163                 | 79                      | 34                |
| ALPE-99               | 156                 | 73                      | 39                |
| ASPE-22               | 169                 | 88                      | 42                |
| ALPE-57               | 159                 | 74                      | 45                |
| Benoni                | 121                 | 36                      | 22                |
| Irish Peach           | 113                 | 45                      | 28                |
| American Mother       | 162                 | 35                      | 22                |
| CD <sub>0.05</sub>    | 3.831               | 3.672                   | 5.046             |



**Fig. 1: Yield potential of scab resistant hybrids and check cultivars (1 = ASPE-99, 2 = ASPE-36, 3 = ALPE-99, 4 = ASPE-22, 5 = ALPE-57, 6 = Benoni, 7 = Irish Peach & 8 = American Mother)**

ALPE-99, followed by ASPE-99 (58 kg plant<sup>-1</sup>) and ALPE-57 (55 kg plant<sup>-1</sup>), whereas a low yield of 48 kg plant<sup>-1</sup> was recorded in ASPE-22, however it was still higher than 'Irish Peach' and 'American Mother' (Fig. 1). Yao *et al.* (2012) reported significant variation in the yield potential of eight apple cultivars which ranged from 10.8 to 54.5 kg tree<sup>-1</sup>.

All the hybrids in present study showed higher productivity and possessed superior characteristics (colour, flavour, juiciness, sugar, size, TSS, sugar content and storage life) in comparison to check cultivars, which make them suitable for commercial cultivation. However, three hybrids (Plate 1) ASPE-99 (Sunhari x Prima), ASPE-22 (Sunhari x Prima) and ALPE-57 (Lal Ambri x Prima) which showed outstanding performance during evaluation hold promise as prospective genetically improved early season scab resistant apple genotypes for release and mass adoption under Kashmir conditions.

**Acknowledgement:** This research work was supported by the Indian Council of Agricultural Research, New Delhi, under the Emeritus Scientist Scheme to senior author.

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