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Evaluation of exotic Apple cultivars under high density planting systems of north western Himalayan region

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Abstract

The present investigation entitled "Evaluation of exotic apple cultivars under high density planting systems of North western Himalayan region" was undertaken at experimental fields of Division of Fruit Science, SKUAST-Kashmir, during the year 2017. Eight different exotic apple cultivars introduced from Holland, of uniform age namely Mitch Gala, Elrosa, Wiltons Star, Golden Delicious Reinders, Red Delicious Campsur, Red Braeburn, Jonagold A and Jonagold DC Robijin on M9T337 rootstock, were evaluated under the Kashmir conditions for fruit and yield characteristics. Among the different varieties Red Delicious Campsur recorded the maximum fruits per cluster (3.74), fruit set (65.15), fruit retention (34.31) percentage, yield (2.66 kg/tree) as well as yield efficiency (1.03 kg/cm²). However, in cultivar Wiltons star maximum leaf fruit ratio (27.50) was observed. In terms of maturity cultivar Mitch Gala was the earliest variety to harvest while Golden Delicious Reinders being the late maturing cultivar.

Keywords: Exotic, Apple, Fruits, Yield, Characteristics.

Introduction

Apple is the most produced fruits in temperate climate areas and is expanding into subtropical and tropical areas (Brown, 2012) [5]. Present world production of apples is close to 8, 93, 29, 179 metric tons (FAOSTAT, 2016) [8]. In India, the area under apple is 314 thousand hectares with a production of 2872 thousand metric tons and productivity of 6.98 M.T/ha (Anonymous, 2016) [2]. Jammu and Kashmir State being endowed with natural advantages of topography and climate with enormous diversity of agro-climatic conditions has immense scope for horticultural development. Horticulture industry in the state made rapid strides during the last few decades. Among the temperate fruits, apple ranks first covering 43.30 per cent area and 80.18 per cent production. Yield of apple has shown an increase from 4.12 to 12.16 MT/ha (1975-2016). The area under apple cultivation in Jammu and Kashmir state is 162.97 thousand ha with the production of 11726.83 thousand MT and productivity 10.60 MT/ha (Anonymous, 2017) [3]. However, the productivity of Jammu and Kashmir is very low as compared to the productivity of countries like Chile (47.22 MT/ha) and Netherlands (44.97 MT/ha). The main reason for low productivity is that almost all the orchards in Kashmir are under the conventional system of planting and are of seedling origin. Low production, continuing decline in the availability of cultivable land, rising land costs together with the mounting demand of horticultural produce, have given thrust to the concept of high density planting (HDP). High density orcharding appears to be the most appropriate answer and need of the hour to overcome low productivity and long gestation period for early returns (Goswami *et al.*, 2014) [9].

Such an initiative to assess newly introduced apple varieties has been taken up by SKUAST-Kashmir, Srinagar J&K by introducing new exotic apple varieties in 2013 onwards. These varieties are under evaluation at the Shalimar campus for high density orcharding system. Under the present study, the performance of the eight exotic cultivars of apple was studied during 2017 for different fruit and yield parameters.

Material and Methods

District Srinagar, situated between 35° 5'-35° 7' North latitude and 74° 8'-74° 9' East longitude and at an altitude of 1500 meters above mean sea level, is flanked by lofty Himalayan ranges on South East and North East sides. At the base of these ranges towards the North-East side

lies the University campus, about 15 km from the main city. Eight exotic varieties of apple grafted on M9-T337 rootstock were introduced from Holland by SKUAST-Kashmir in in summer 2016 (9th June). In order to access the performance of these exotic cultivars, it was proposed to conduct the study on their floral, fruit and yield characteristics in year 2017. The plant material was two year old knip boom trees planted at a spacing of 3x1m. The total number of flowers per cluster and average number of fruits per cluster of each experimental unit were counted and averaged. In case of leaf fruit ratio, the number of leaves per fruit of each experimental unit were counted and averaged. Fruit set percentage as shown in Fig.1 was calculated by using the following formula given by Westwood (1978) and expressed in percentage:

$$\text{Fruit set (\%)} = \frac{\text{Number of fruitlets at pea stage}}{\text{Numbers of flowers}} \times 100$$

The fruits retained in all the cultivars were recorded one week before harvesting of fruits, averaged and expressed in percentage as under given by Westwood (1978):

$$\text{Fruit retention (\%)} = \frac{\text{Number of fruits at harvest}}{\text{Number of fruitlets at pea stage}} \times 100$$

The crop harvested from each experimental unit was recorded and average yield was expressed in kilogram per tree. Yield efficiency of the tree was calculated and expressed as kg/cm² by using the formula given by Westwood (1993)^[18].

$$\text{Yield efficiency} = \frac{\text{Yield (kg)}}{\text{Tree trunk cross sectional area (cm}^2\text{)}}$$

Finally, the fruit maturity was observed with the help of starch iodine test (0-6 scale) and the dates thus recorded were converted into days.

The observations recorded during the course of investigation were subjected to statistical analysis as per the method of 'Analysis of Variance'. The significance and non-significance of treatment effects were judged with the help of software OP stat. The significant difference on the means was tested against the critical difference at 5% level.

Result and Discussion

The varieties under study exhibited significant difference in terms of flowers per cluster. Mitch Gala showed maximum number of flowers per cluster (6.00) and minimum number was observed in Jonagold DC Robijin (5.16). In case of fruits per cluster maximum number was recorded in Red Delicious Camspur (3.74) and minimum in Jonagold DC Robijin (2.70). The differences observed may be due to the varietal characters as well as the genetic constitution of the variety. The number of flowers is important in the fruit set being related to the length and age of the branch. The varieties under trail exhibited significant differences in terms of their fruit characteristics. It has been suggested that there should be 30-40 leaves for the quality production of a single fruit in case of apples. However, for high density plantation this number is relatively low which was confirmed in our research. The highest leaf fruit ratio was observed in cultivar Wiltons Star (27.67) while the least ratio was observed in Red Delicious Camspur (19.45). The increase the ratio of leaf area to fruit, resulting in an increased amount of available assimilates supporting fruit growth (Palmer *et al.*, 1991)^[17]. Fruit set in temperate fruits has been reported to depend upon the prevailing environment during flowering as well as the period following fruit set. In the present study the highest fruit set was observed in cultivar Red Delicious Camspur (65.15%) while as lowest in Jonagold DC Robijin (52.36%). Besides genetic differences, there could be an array of reasons for such differences in fruit set among the varieties like temperature, weather conditions, atmosphere which is conducive for bee flight, pollen compatibility etc. Lauri *et al.* (1996) suggested that the fruit set would happen in response to position of the inflorescence in the canopy, affecting the vegetative development and finally, the inflorescence growth. Some authors consider the influence of the bud size in the fruit set and quality (Nachtigall, 2000)^[16]. The cultivar Red Delicious Camspur recorded highest fruit retention percentage of 34.31% while as lowest fruit retention percentage was recorded in Jonagold DC Robijin (25.59%). The fruit set and retention under open pollination is effected by number of factors like genetic makeup of cultivars, closeness or farness from the compatible pollen source, prevailing weather conditions, bee activity, stigma receptivity, pollen germination, pollen tube growth, diploid or triploid nature of varieties, post bloom temperature and the fertilization process. Variation in fruit setting and retention in open pollination has been reported by many workers.

Table 1: Floral and fruit characteristics of exotic apple cultivars

Cultivar	Flowers per cluster	Fruits per cluster	Leaf Fruit ratio	Fruit set percentage	Fruit retention percentage
Mitch Gala	6.00	3.61	24.00	60.16	31.16 (5.67)*
Elrosa	5.33	3.26	20.31	61.16	31.83 (5.44)
Wiltons Star	5.99	3.24	27.50	54.09	26.00 (5.19)
Golden Delicious Reinders	5.83	3.70	25.37	63.46	33.18 (5.84)
Red Delicious Camspur	5.74	3.74	19.96	65.15	34.31 (5.94)
Red Braeburn	5.99	3.37	26.17	56.26	27.14 (5.30)
Jonagold A	5.24	3.06	21.35	58.39	28.65 (5.73)
Jonagold DC Robijin	5.16	2.70	23.81	52.36	25.59 (5.15)
C.D(p≤ 0.05)	0.59	0.02	0.89	0.49	0.62

*Data in the paranthesis is the square root transformation of the original values















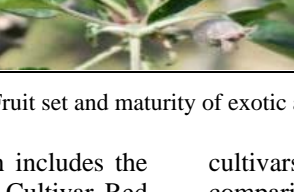
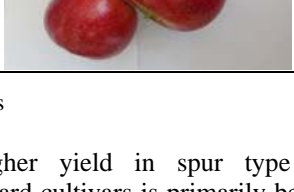
Variety	Fruit set	Fruit maturity
Mitch gala		
Elrosa		
Wiltens star		
Golden Delicious Reinders		
Red Delicious Camspur		
Red Braeburn		
Jonagold A		
Jonagold DC Robijin		

Fig 1: Fruit set and maturity of exotic apple cultivars

The yield efficiency is a complex index which includes the vegetative growth of tree and its productivity. Cultivar Red Delicious Camspur recorded the highest yield (2.66 kg/tree) as well as yield efficiency (1.03 kg/cm²) whileas lowest yield and yield efficiency was observed in Jonagold DC Robijin (1.17 kg/tree) and Elrosa (0.38 kg/cm²), respectively. Yield efficiency was expressed by means of trunk cross sectional area as reported by Kiprijanovski *et al.* (2009) [13] which is an important indicator of tree's productivity. Our research results are in line with results obtained by Baritt *et al.* (1997) [4] who reported that cumulative yield efficiency showed a linear decline as tree size is increased. Our results are further supported by Hasani *et al.* (2014) [10] who observed that spur type cultivars were more yield efficient than standard

cultivars. This higher yield in spur type cultivars in comparison to standard cultivars is primarily because of their genetic makeup towards more spur formation and precocity. Yield variations among various apple cultivars have been reported by many workers (Fallahi *et al.*, 1994) [7]. The present study showed that varieties exhibited characters of mid and late season maturation. Cultivars M itch Gala and Jonagold DC Robijin matured at 122 and 128.25 days after full bloom, respectively. Cultivars Elrosa and Wiltens Star, Red Delicious Camspur, Red Braeburn and Jonagold A matured at 132.25, 146.75, 149.75, 154.75 and 157.50 days after full bloom, respectively. The variety Golden Delicious Reinders took maximum number of days (159.00 days) to reach to the maturity. The variation among cultivars in the

date of maturity may be due to the difference in their genetic makeup and inherent parental characters of these varieties. Ingle and D'souza (1986) [11] reported similar harvest time for Red Delicious cultivars (130-144 days). According to Karacali (2004) [12], harvest date depends on cultivar, place, year, rootstock and ecological conditions. Akhtar *et al.* (2002) [1] also reported that Gala group matured in mid-august and took 135 days while as cultivars Jonica, Jonagored, Golden Delicious and Fiesta matured in the month of September and took 167-170 days. These results are further supported by findings of Matinger and Stainer (1990) [15] who reported that

the new variety Gala, derived from the cross between Golden Delicious and Kidd's Orange Red and its mutants showed early ripening. Our results are also in conformity with Das *et al.* (2011) [6] who found that cultivars like Vance Delicious, Starkrimson, Oregon Spur, Red Chief, Gala Must, Royal Delicious, Red Delicious and Golden Delicious took 110, 117, 117.5, 120, 125, 120, 132 and 145.5 days, respectively to attain maturity. The variations to reach at commercial harvest stage may probably be due to high and low temperature and seasonal variations.

Table 2: Yield characteristics of exotic apple cultivars

Cultivar	Yield kg tree ⁻¹	Yield efficiency (kg/cm ²)	Maturity time (DAFB)
Mitch Gala	2.30	0.41	122
Elrosa	1.81	0.38	132.25
Wiltons Star	1.77	0.41	146.75
Golden Delicious Reinders	2.56	0.47	159.00
Red Delicious Camspur	2.66	1.03	149.75
Red Braeburn	1.89	0.45	154.75
Jonagold A	2.21	0.80	157.50
Jonagold DC Robijin	1.17	0.65	128.25
C.D ($p \leq 0.05$)	0.11	0.11	0.75

DAFB: Days after full bloom

Conclusion

Among the eight exotic apple cultivars evaluated, Red delicious Camspur ranked first in terms of fruit set, fruit retention, yield and yield efficiency. Mitch Gala followed by Jonagold DC Robijin were early maturing cultivars. Thus the best performed varieties in terms of productivity and fruit maturity can be recommended for commercial adoption by the orchardists of Kashmir valley.

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