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Short communication

Performance of exotic apple varieties grafted on M9T337 clonal rootstock under high density plantation

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ABSTRACT

Average number of flowers/ cluster was found highest in 'Fuji Zehn Aztec' (5.92) and average number of fruits/cluster was recorded in 'Golden Clone B' (3.24). Fruit to leaf ratio was found maximum in 'Golden Clone B' (34.65) and lowest in 'Super Chief Sandidge' (25.28). Fruit set (%) and Fruit retention (%) was observed maximum in variety 'Golden Clone B' (85.09% and 48.49% respectively). Highest yield and yield efficiency was observed highest in 'Golden Clone B' (4.95 kg/tree and 1.42 kg/cm^2 respectively). As per the maturity 'Gala Red Lum' may be categorized as early, 'Super Chief Sandidge' as mid-season and 'Fuji Zhen Aztec' and 'Golden Clone B' found late. The overall results indicate that the introduced apple varieties are characterized with different biological and quality polymorphism. All of the studied varieties show positive characteristics and can be recommended for further evaluation and mass multiplication.

Key words: *Malus* × *domestica*, M9T337, flowering, yield, high density

Apple (*Malus* × *domestica* Borkh.), also known as king of temperate fruits belonging to the family Rosacea is one of the most cultivated temperate fruits in the world. In India, its production is limited to Jammu and Kashmir, Himachal Pradesh, Uttrakhand and to some parts of north eastern states. Jammu and Kashmir is the leading producer of apples in India with an annual production of 1726.83 thousand metric tonnes and productivity of 10.5 MT/ha (FAOSTAT, 1). Although the state shares highest productivity yet it is far below the level achieved by advanced countries where productivity is of 50-60 MT/ha (FAOSTAT, 1). Major cause of low productivity is attributed by low density plantings, use of seedling origin varieties and planting with single variety 'Delicious' group of varieties. The vigorous seedling rootstock leads to larger trees, which have long juvenility. Modern orchard planting systems are based on higher tree densities ranging from 1000 to 6000 trees per hectare (Robinson, 2). For the temperate region to prosper in apple, it is imperative to shift to new varieties which have both high yield potential as well as good marketability. In such an attempt four newly introduced exotic apple varieties grafted on M9T337 rootstock were studied for their various fruit production and yield characteristics so that they may be recommended for mass multiplication and to compete with the international markets for both yield and quality.

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The experiment was conducted during 2014 on 2 year old plants grafted on M-9T337 rootstock introduced in spring 2013 from GRIBA Nursery, Italy and planted in the experimental field of SKUAST-K, Shalimar Campus. The orchard is situated between 35º.5'-35º.7' North latitude and 74º.8'-74º.9' East longitude and at an altitude of 1500 meters above mean sea level, flanked by lofty Himalayan ranges on South East and North East sides. Uniform plants of four exotic varieties *viz.* Super Chief Sandidge, Gala Red Lum, Fuji Zehn Aztec and Golden Clone B at a spacing of 3 × 1.5cm were selected and the experiment was laid in Randomized Complete Block Design (RCBD) with five replications and two trees per treatment as plot size. The total number of flowers per cluster, number of fruits per cluster and number of leaves per fruit of each experimental unit were counted and averaged. The diameter of flowers of selected trees was measured with measuring scale in centimetres and averages were taken in taken statistical analysis. Fruit set (%) and fruit retention (%) was calculated using the standard methods (Fig. 1). The fruits dropped after initial fruit set were counted. The fruit drop was determined by dividing the number of fruits initially set to the number of fruits retained at harvest and multiplied by 100. Maturity time (Days from bloom to harvest date) was observed with the help of starch iodine test (0-6 scale). The dates thus recorded were converted into days. The crop harvested from each experimental unit was recorded and expressed in kilogram per tree as yield. Yield

(a) Fruit set **(b) Fruit retention**

Fig. 1. Fruit development stage at which fruit set (a) and fruit retention (b) were recorded.

efficiency and yield per canopy area of the tree was calculated and expressed as kg cm^{-2} by using the formula given by Westwood (3).

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

$$\text{Yield per canopy} = \frac{\text{Yield (kg)}}{\text{Canopy area (cm}^2\text{)}}$$

The varieties under trail exhibited significant differences in flowering parameters. The variety 'Fuji Zehn Aztec' bears maximum number of flowers/cluster (5.92) and the minimum number was observed in 'Super Chief Sandidge' (5.22); while maximum number of fruits/cluster was observed in 'Golden Clone B' (3.24) and the minimum number in 'Fuji Zehn Aztec'. 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. This characteristic would be related to the length and age of the branch. Diameter of flowers varied significantly among the varieties under trail. The diameter of flowers (4.56 cm) in 'Golden Clone B' was found significantly larger in comparison to other varieties. The flower size being a genetic character varies even from variety to variety within given species. Reproductive success including fruit production increases with increase in inflorescence size (Firmage and Cole, 4). The present study therefore, substantiate the higher fruit set obtained in 'Golden Clone B'. It has been suggested that there should be 30-40 leaves for the quality production of a single fruit. However, for high density plantation this number is relatively low which was confirmed in our research. The highest fruit leaf ratio was observed in variety 'Golden Clone B' (34.65); while the least ratio was observed in variety in 'Super Chief Sandidge' (25.28), as it is highly spur variety (Table 1).

There was significant variations recorded for fruit set as well as fruit drop. The variations in fruit set among different varieties may be because of their genetic differences. Fruit set in temperate fruits has been reported to depend upon the prevailing environment during flowering as well as the period

Table 1. Floral/fruit characteristics of exotic apple varieties grafted on M9T337 clonal rootstock.

Variety	No. of flowers/cluster	Diameter of flower (cm)	No. of fruits/cluster	Fruit leaf ratio
Super Chief Sandidge	5.22 ± 0.08	3.65 ± 0.10	2.52 ± 0.03	25.28 ± 0.19
Gala Red Lum	5.50 ± 0.19	4.51 ± 0.13	3.12 ± 0.07	29.57 ± 0.04
Fuji Zehn Aztec	5.92 ± 0.03	3.74 ± 0.05	2.28 ± 0.08	31.29 ± 0.08
Golden Clone B	5.72 ± 0.08	4.56 ± 0.04	3.24 ± 0.08	34.65 ± 0.04
CD ($p \leq 0.05$)	0.36	0.28	0.22	0.35

following fruit set. In the present study highest fruit set was observed in 'Golden Clone B' (85.09%) while it was lowest in 'Fuji Zehn Aztec' (57.48%) (Table 2). Besides genetic differences, there could be an array of reasons for such differences in fruit set among the varieties like temperature, weather conditions, the atmosphere which is conducive for bee flight, pollen compatibility etc. Lauri *et al.* (5) 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. Our research results were in conformity with the findings of Madial *et al.* (6) who reported that low fruit set in Fuji is due to high amount of vegetative buds in this cultivar.

The variety 'Golden Clone B' showed the lowest fruit drop (50.52%) and highest fruit retention (48.49%), while the variety 'Fuji Zehn Aztec' showed highest per cent of fruit drop (69.27%) and lowest fruit retention percentage (Fig. 2). This drop could be due to environmental adversities like water stress, poor nutrition etc. or due to competition between fruits on the plant. It can also occur due to high temperature. It is a common observation that pre-harvest fruit drop is more in varieties characterized by high rates of fruit set. Teskey and Shoemaker (7) claimed that in apple, fruit containing less than 3 seeds are shed first when fruit set was abundant. Fruit species producing fruits containing more than one seed (apple, pear and quince) drop preferably those fruits which contain the less number of seeds. Such fruits are genuinely more susceptible to environmental adversities *i.e.*, water stress, poor nutrition etc. and are therefore more prone to fruit drop.

The most important criteria in apple cultivars are duration between full bloom and harvest date. This is important factor in determination of appropriate

Table 2. Fruit retention and yield characteristics of exotic apple varieties grafted on M9T337 clonal rootstock.

Variety	Fruit set (%)	Fruit drop (%)	Fruit retention (%)	Maturity time (DFBHD)	Yield (kg/ tree)	Yield efficiency (kg/cm^2)	Yield per canopy area (kg/cm^2)
Super Chief Sandidge	62.55 ± 0.45	59.33 ± 0.12	41.05 ± 0.27	155.1 ± 1.23 (28 Sept.)	2.45 ± 0.40	0.66 ± 0.09	0.88 ± 0.01
Gala Red Lum	75.97 ± 0.32	55.00 ± 0.26	45.75 ± 0.16	131.2 ± 0.08 (31st Aug.)	2.43 ±0.14	0.60 ± 0.03	0.29 ± 0.004
Fuji Zehn Aztec	57.48 ± 0.44	69.27 ± 0.20	30.77 ± 0.22	160.9 ± 0.24 (2 Oct.)	2.05 ± 0.30	0.43 ± 0.07	0.19 ± 0.005
Golden Clone B	85.09 ± 0.35	50.52 ± 0.25	48.49 ± 0.81	169.3 ± 0.18 (11 Oct.)	4.95 ± 0.45	1.42 ± 0.15	0.74 ± 0.009
CD (p≤ 0.05)	1.29 (0.07)	0.69	1.25	2.11	0.98	0.26	0.02

DFBHD: days from full bloom to harvest date

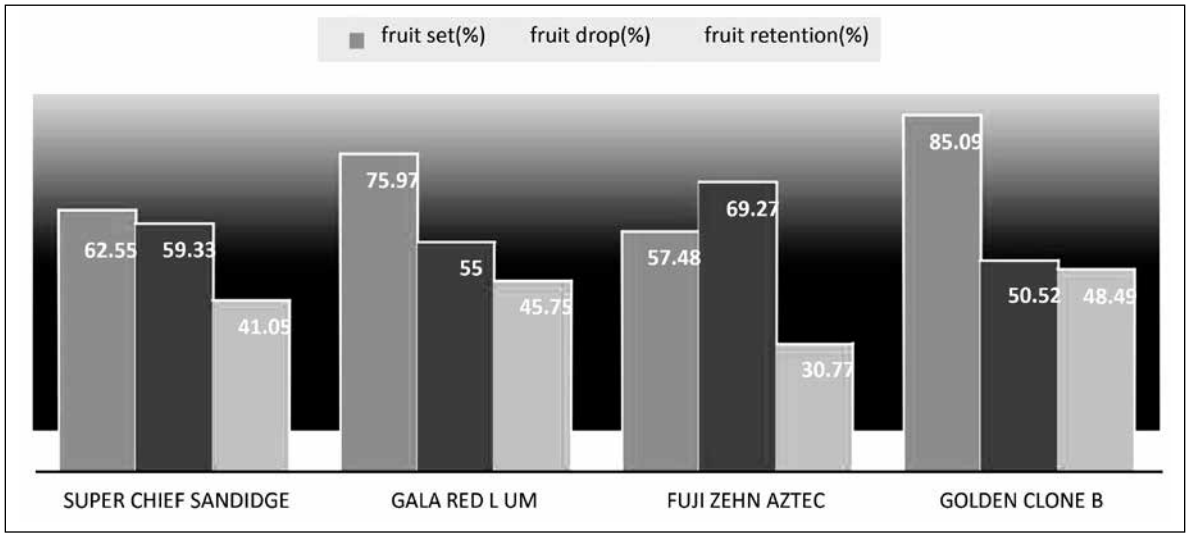

Fig. 2. Fruit production characteristics of exotic apple varieties on M9T337 rootstock.

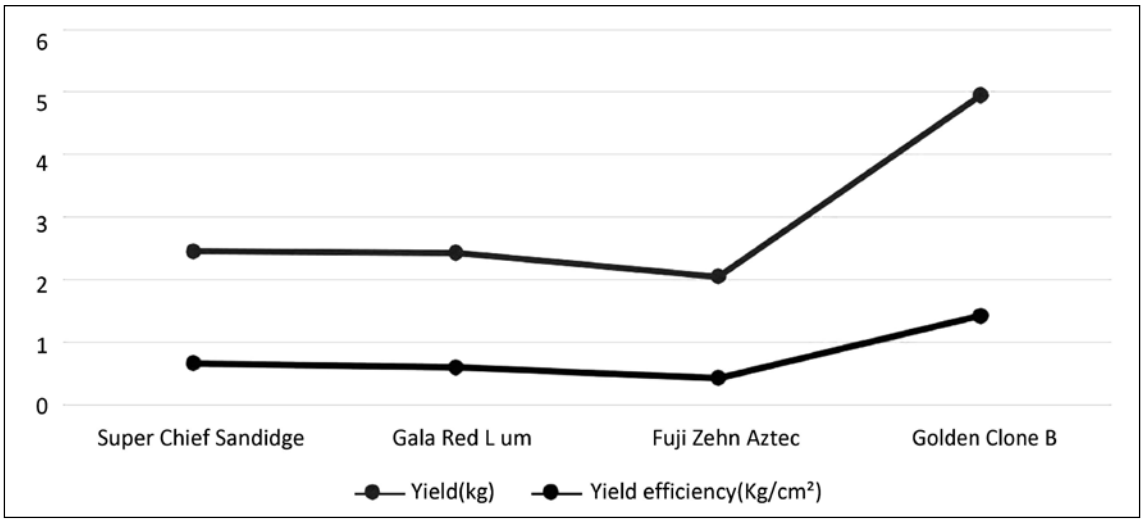

Fig. 3. Yield and yield efficiency of exotic apple varieties on M9T337 rootstock.

date of harvest. The present study showed that varieties exhibited characters of mid and late season maturation. Varieties 'Gala Red Lum' and 'Super Chief Sandidge' matured at 131 and 156 days respectively. The variety 'Golden Clone B' took maximum number of days (169 days) to reach to the maturity (Table 2). 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 (8) reported similar harvest time for Red Delicious cultivars (130-144 days). These results are further supported by findings of Matinger and Stainer (9) 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. The yield efficiency is a complex index which includes the vegetative growth of tree and its productivity. 'Golden Clone B' recorded the highest yield as well as yield efficiency (4.95 and 1.42 kg/ cm^2) while as lowest yield and yield efficiency was observed in 'Fuji Zehn Aztec' (2.05 and 0.43 kg/cm^2) (Fig. 3). Yield per canopy was observed highest in 'Super Chief Sandidge' (0.88) due to high spur density of the variety and lowest in 'Golden Clone B' (0.19) (Table 2). Yield efficiency was expressed by means of trunk cross sectional area as has been reported by Kiprijanovski *et al.* (10) which is an important indicator of tree's productivity. Our research results are in line with results obtained by Baritt *et al.* (11) which reports that cumulative yield efficiency showed a linear decline as tree size is increased. Our research showed difference in yield among various varieties as the yield may have great variations in respect of planting places and regions.

All the varieties under study performed well and exhibited diverse floweing and fruit production characteristics. 'Fuji Zehn Aztec' exhibited high flower bearing habit while highest fruit set was observed in 'Golden Clone B' Interms of yield, 'Golden Clone B' far exceeds other varieties (10MT/ Ha) followed by Super Chief Sandidge (5.4 MT/ Ha) in the second year of plantation with 2222 trees/ha.

REFERENCES

1. FAOSTAT, 2018. Agricultural Statistical Database, available online at: http://faostat.fao.org.
2. Robinson, T.L. 2003. Apple orchard planting system. **In**: *Apples* (Eds. D.C., Ferrec and I.J., Warrington), Cabi Publ., Wallingford, UK. pp: 345-407.
3. Westwood, N.M. 1993. Temperate zone pomology: Physiology and culture (3rd Edition) Timber Press, Portland Oregon
4. Firmage, D.H. and Cole, F.R. 1988. Reproductive success and inflorescence size of *calopogon tuberosus* (orchidaceae). *American. J. Bot.* **75**: 1371-77.
5. Lauri, P.E. Terouanne E. and Lespinasse J.M. 1996. Quantitative analysis of relationship between inflorescence size, bearing-axis size and fruit set an apple trees case study. *Ann. Bot.* **77**: 277-86.
6. Madail, R.H., Herter, F.G., Leite, G.B. and Petri, J.L. 2010. Influence of flower structure in the

flower production and fruit set in some apple cultivars. *Acta Hort.* **872**: 309-11.

7. Teskey, J.E. and Shoemaker, J.S. 1972. Tree fruit production. The AVI Publishing Company Connecticut Westport, pp. 210-15.

8. Ingle, M. and D'souza, M. 1986. Fruit characteristics of Red Delicious apple strains during maturation and storage. *J American. Soc. Hort. Sci.* **114**: 776-80.

9. Mantinger, H. and Stainer, R. 1990. Gala', a new apple variety for fruit growing in South Tyrol. *Erwerbsobstbau*, **32**: 174-78.

10. Kiprijanovski, M., Ristevski, B., Arsov, T. and Gjanovski, V. 2009. Influence of planting distance to the vegetative growth and bearing of apple cultivar 'Jonagold' on rootstock MM106. *Acta Hort.* **825**: 453-58.

11. Barrit, B.H., Konishi, B.S. and Dilley, M.A. 1997. Tree size. Yield and biennial bearing relationships with 40 apple rootstocks and tree scion cultivars. *Acta Hort.* **451**: 105-12.

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