International Journal of Minor Fruits, Medicinal and Aromatic Plants. Vol. 7 (2) : 95-99, December 2021

Observations on relationship of seed content with russeting and fruit physical characteristics of apple cv. Golden Delicious

Munib Ur Rehman[1*], MohdMaqbool Mir[1], Gh. Hassan Rather[1], Ejaz Parray[1], Tajamul Nissar[2], TashiAngmo[1]

[1]High Mountain Arid Agricultural Research Institute – Leh, India
Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir-Shalimar
[2]Faculty of Horticulture
Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir-Shalimar, India
[3]Department of Zoology, Bhagwant University, Rajasthan, India

Email: munib11.mr@gmail.com

Received : 18.03.21 ; Revised : 20.05.21 ; Accepted : 25.05.21

ABSTRACT

Apple (Malus x domestica Borkh.) seeds during their development in the fruit, produce a sequence of different types of hormones,influencing fruit growth and quality in diverse ways.This way role of seeds can also be postulated in fruit russeting of apple. So this study was framed to identify the relationship of fruit seed content with qualitative factors like length, diameter and weight,and also russeting incidence in apple cv. 'Golden Delicious'. Though seed content of the fruit seemed to influence significantly all the above factors, but could only explain the variability in russeting up to 29%, which indicates that there may be many more factors associated with fruit russeting of 'Golden Delicious' apple. The study indicated that weight, length and fruit diameter were relatively strongly related to the seed content explaining the variability of 43%, 45% and 46% respectively. Moreover, russeting also influenced negatively the fruit size factors in association with seed number.

Keywords: Fruit quality, fruit size, pollination, russeting, seed number

INTRODUCTION

Pollination is one of the first and most important steps in fruit production. Often low yield and/or poor fruit quality are attributed to poor pollination (Garratt *et al*. 2014). Pollination as such ultimately leads to fertilization and seed development, and influences the number and distribution of seeds within the fruit, which has long been known to influence fruit quality and quantity (Drazeta, 2002, Garratt *et al*. 2014). At least ten pollen grains are needed to produce a full complement of seeds for most apple cultivars, though due to varying levels of non-viable pollen and genetic incompatibility issues inherent with orchards, many more grains are usually required for seed set (Sheffield *et al*., 2005). It is accepted that seeds play a role in sink strength probably through the production of hormones (Balaguera-Lopez *et al*.,2020). Therefore, one can expect that sink strength (and thus fruit physical characteristics) of apple fruits depends partially on seed number.

A crop of small apples is worth less than the same weight of larger apples, thus the individual fruit size needs to be taken into account in accessing crop performance. In multi-seeded fruits, weight sometimes can be related to the number of seeds which develop. There is an upper limit to seed number, set by the number of ovules formed during flower development, and in some fruits a limit to tissue development associated with each seed can be postulated. These factors may determine the maximum weight which fruit can attain, against which actual weights can be compared. Any shortage would then be accounted for by poor pollination or tissue development, or a combination of both (Rehman *et al*., 2018).

Apple seeds during their development in the fruit, produce a sequence of different types of hormones, the appearance of which is linked with successive stages in the development of the endosperm and embryo. The development of a free nuclear endosperm is characterized as first stage, and is associated with the presence of cytokinins (Zhang *et al.,* 2020).Then after 4 to 5 weeks, the first stage is terminated with the development of cellular primary endosperm, where in auxins can be noticed. Several GA's have also been confirmed to be present during this second stage, peaking at the time when embryo has almost reached its final size (Bermejo *et al*., 2018).

In view of the hormone-directed transport, it seems reasonable to suggest that one of the main functions of the relatively high concentrations of hormones found in developing seeds may be the mobilization of essential metabolites – particularly carbohydrates and soluble nitrogen – against the competing demands of the growing shoots. It is certainly true that fruits with no seeds or with only a low seed content are not normally able to survive this competition, though they can be made to develop if competing growth is suppressed (Abbott, 1960).

There is also strong circumstantial evidence that gibberellins translocated from the seeds to the bourse may inhibit flower initiation in the bourse buds, thus giving rise to a phenomenon where it can also be translocated to the epidermis and help in controlling the russet formation. Hence, this study was aimed to find out the role of fruit seed content in defining the fruit physical characteristics and russeting disorder of Golden Delicious apple fruit.

MATERIALS AND METHODS

The present study was carried out at a private orchard in Shalimar (34º08'54" towards North and 74º53'03" towards East), near Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir during the year 2018. Kashmir represents the temperate climatic conditions. The maximum and minimum temperature of valley during the growing season ranged from 23ºC and 29.9ºC and -5.8ºC to 12ºC, respectively with relative humidity of 43.9% and 650-800 mm rainfall mostly received during the period December to April. Trees used in this experiment were 18 year old "Golden Delicious" on seedling rootstock. The trees were spaced at 6m x 6m on clay loamy soil. All the Trees were managed according to the normal and uniform management practices. Russeted and russet free fruits (104 in number) were randomly selected covering all the four directions at harvest. Fruit length and diameter were measured using digital vernier caliper, and the weight using digital balance. Approximate Russet percentage of each fruit was calculated using the formulae:

$$Russet\% = \frac{Russeted\ area}{Total\ fruit\ surface\ area} x100.$$

Fruits were cut into two halves and the seed count was noted for each fruit.

Regression analyses were conducted using the 'lm' procedure of the R statistical software. The regressor (seed number) was evaluated for its effects on the russeting percentage, fruit length, diameter and weight. Moreover, combined effects of russeting and seed number were also tested in relation to fruit length, diameter and weight.

RESULTS AND DISCUSSION

Fruit characteristics of apple cv. Golden Delicious, in this study were found to be influenced by the seed number. All the four response variables (russeting, fruit length, fruit diameter and fruit weight) were significantly ($P<0.001$) related to fruit seed content. Fruit length, fruit diameter and fruit weight showed a positive correlation with the seed count. Whereas, the russeting percentage was negatively correlated with seed number *i.e.* with the increase in fruit seed number, the russeting percentage was reduced (Fig. 1). However, fruit russet percentage showed a poor ($R^2<0.29$) relationship with seed content (SN) (Fig.2). Golden delicious apple are susceptible to russeting. It has been observed that application of exogenous gibberellin's, controls russeting in apple to a great extent(Taylor *et al.,* 1986; Pesteanu, 2018), but at the same time immature apple seeds are exceptionally rich sources of gibberellins: GA_1, GA_3, GA_4, GA_7, GA_{20} andGA_{34}(Stephen *et al*., 1999). Seed number on fruit russeting could only explain variability of 29% in this case. Thus it is hypothesized that seeds affect the sink of individual fruits, probably through hormones in a quantitative and qualitative way. Here fruit epidermal features specific to the particular variety must be influencing the relation. Moreover, environment, location and other unidentified factors may account for the unexplained variability of the results.

The relationships of seed number with the variables, fruit length, diameter and weight were little stronger ($R^2< 0.45$), ($R^2< 0.46$) and ($R^2< 0.43$) respectively (Fig.3 – 5). Further, fruit weight was

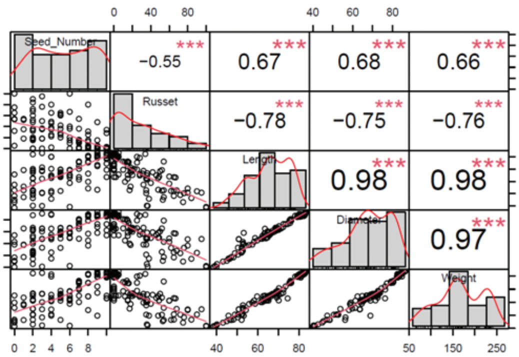

Fig. 1: Correlation plot of seed number, russeting, fruit length, diameter and weight of Golden Delicious apple.

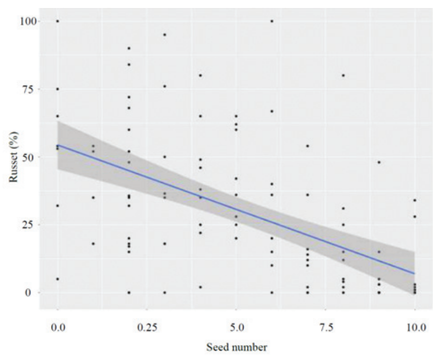

Fig. 2: Relationship between Russet % and seed content of Apple cv. Golden Delicious, Regression line Y = 54.4-4.746*X, r^2=0.29, n=104

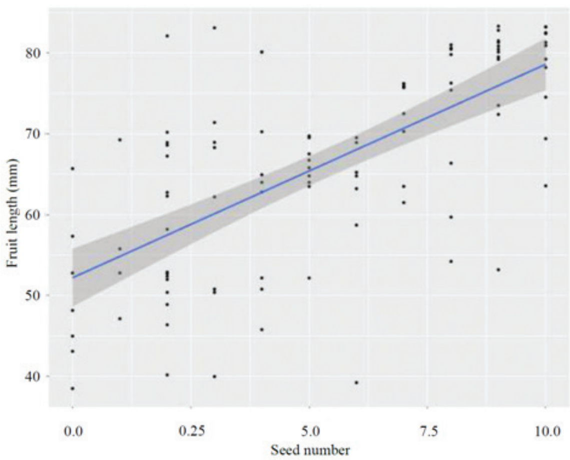

Fig. 3: Relationship between fruit length and seed content of Apple cv. Golden Delicious, Regression line Y = 52.21+2.639*X, r^2=0.45, n=104

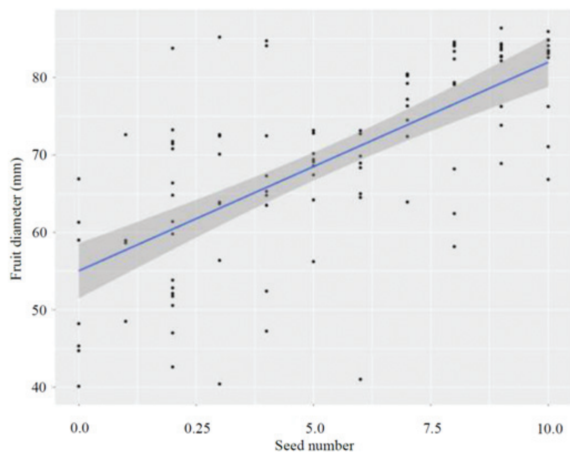

Fig. 4: Relationship between fruit diameter and seed content of Apple cv. Golden Delicious, Regression line Y = 55.02+2.697*X, r^2=0.46, n=104

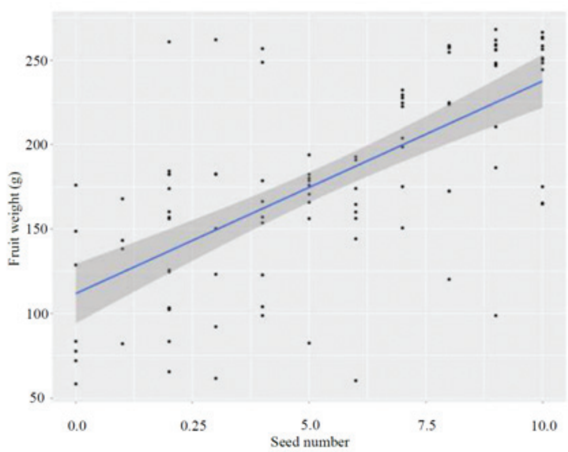

Fig. 5: Relationship between fruit weight and seed content of Apple cv. Golden Delicious, Regression line Y = 111.79+12.58*X, r^2=0.43, n=104

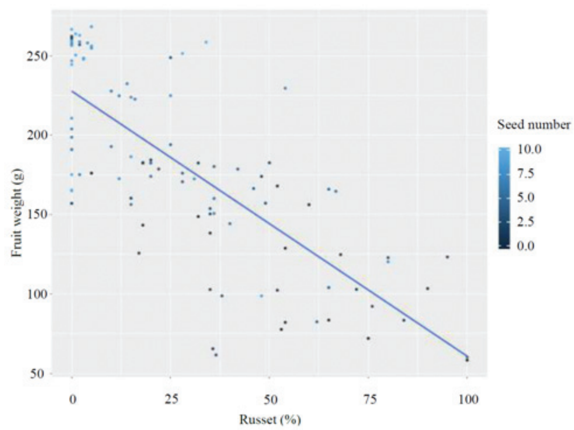

Fig.6: Regression plot of fruit weight on two predictor variables (russet and seed number) of Apple cv. Golden Delicious, Regression line Y = 180.26+6.58*(seed number) 1.263* X+ 0.002* X* (seed number), r^2=0.66, n=104

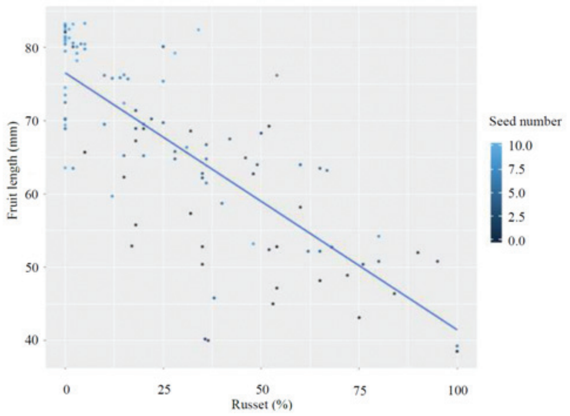

Fig.7: Regression plot of fruit length on two predictor variables (russet and seed number) of Apple cv. Golden Delicious, Regression line Y = 67.34+1.26*(seed number)-0.29*X+0.005* X*(seed number), r^2=0.68, n=104

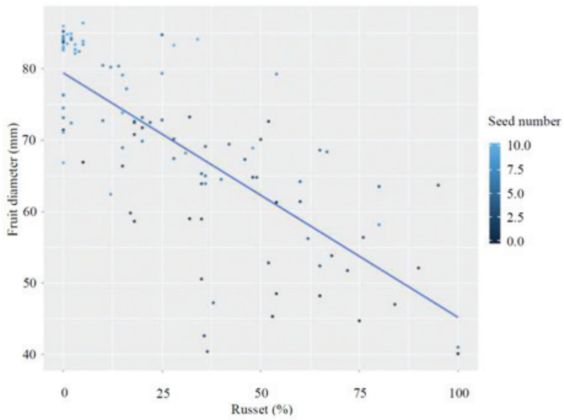

Fig. 8: Regression plot of fruit diameter on two predictor variables (russet and seed number) of Apple cv. Golden Delicious, Regression line Y = 70.05+1.27*(seed number)-0.3* X+0.011* X*(seed number), r^2=0.67, n=104

more strongly (R^2<0.66) related when the combination of russet % and seed content were taken into consideration. Same sort of relationships for fruit length (R^2< 0.68) and diameter (R^2< 0.67) were observed with the combination of russet % and seed content.

Seed content could explain the variability of fruit length and diameter up to 45% and 46% respectively. Seed number explained 43% of variability in fruit weight of the cultivar'Golden Delicious'. The increase in fruit weight with increasing plump seed number agrees with reports of Ward *et al.*(2001). The results described here suggest that the sink strength of apple crop cv. 'Golden Delicious' changes in nearly, but not precisely, directly proportional to the number of apple seeds.Seed distribution resulting from pollination levels, dictates fruit quality. The growth of a particular sector is principally influenced by the seeds within its locule. Each carpel exerts a somewhat autonomous effect on fruit growth and, at least partially, develops as a unit. There is a week seed influence with increasing distance from the sector indicating that seeds principally govern fruit development (Drazeta *et al.*,2004). Scheffield (2014) clearly demonstrated and suggested that fruit growth in response to seed presence occurs primarily on a single plane – outward horizontally from the carpels and contributes to increased fruit diameter.

The explanations were more strong (68% for length and 67% for diameter) when seed number was taken in combination with russeting percentage. Same was the case with fruit weight, where again the variability was more strongly (66%) explained with the combination of factors, russet% and seed number. This clearly indicates that russeting too may be influencing inversely the fruit size factors of 'Golden Delicious' apple fruit.

Conclusion

The study leads us to conclude that fruit size features like length, diameter and weight are influenced by the seed content of that fruit in a positive way. The russeting disorder in 'Golden Delicious' apple can be reduced to some degree with the enhancement of fruit seed number, by means of proper pollination. Though, there may be many more factors contributing towards structuring all these parameters. Further, russeting also has a role in reducing the size features of the fruit.

REFERENCES :

Abbott, D.L. 1960. The bourse shoot as a factor in the growth of apple fruits. *Ann. Appl. Biol.*, **48**:434-438.

Balaguera-Lopez, H.E.; Fisher, G. and Magnitskiy, S. 2020. Seed-fruit relationships in fleshy fruit species: Role of hormones. A Review. *Revista Colombiana de Ciencias Horticolas*. **14**(1): 90-103.

Bermejo, A.; Granero, B.; Mesejo, C; Reig, C.; Tejedo, V.; Agusti, M.; Primo-Millo, E. and Iglesias, D.J. 2018. Auxin and Gibberellin Interact in Citrus Fruit Set. J. of Plant Growth Regulation. **37**:491-501.

Drazeta, L.; Lang, A.; Hall, A.J.; Volz, R.K. and Jameson, P.E. 2004. Modeling the influence of seed set on fruit shape in apple. *Journal of Horticultural Science & Biotechnology*,**79**(2):241-245.

Drazeta, L.R. 2002.Structure, function and quality development in apples.PhD Thesis.Massey University. New Zealand. 160pp.

Garratt, M.P.D.; Breese, T.D.; Jenner, N.; Polce, C.; Beismeijer, J.C. and Potts, S.G. 2014. Avoiding a bad apple: insect pollination enhances fruit quality and economic value. *Agriculture, Ecosystem & Environment,***184**:34-40.

Garratt, M.P.D.; Truslove, C.L.; Coston, D.J.; Evans, R.L.; Moss, E.D.; Dodson, C.; Jenner, N.; Beismeijer, J.C. and Potts, S.G. 2014. Pollination deficits in UK apple orchards. *Journal of Pollination Ecology*,**12**(2):9-14.

Rehman, M.U.; Tak, Z.A.; Parray, E.A.; Qayoom, S.; Yasmeen-Gull and Kumar, A.G. 2018. Effect of some plant bioregulators on fruit yield and quality characteristics of Apple cv. Red Delicious. *International Journal of Minor Fruits, Medicinal and Aromatic Plants*, **4**(1):33-39.

Scheffield, C.S. 2014. Pollination, seed set and fruit quality in apple: studies with *Osmialignaria* (Hymenoptera: Megachilidae) in the Annapolis valley, Nova Scotia, Canada. *Journal of Pollination Ecology,***12**(13):120-128.

Sheffield, C.S.; Smith, R.F. and Kevan, P.G. 2005. Perfectsyncarpy in apple (*Malus x domestica* 'Summerland McIntosh') and its implications for pollination, seed distribution and fruit production (Rosaceae: Maloideae). *Annals of Botany*, **95**:583-591.

Stephan, M.; Bangerth, F. and Schneider, G. 1999.Quantification of endogenous gibberellins in exudates from fruits of *Malusdomestica*. *Plant Growth Regulation*, **28**: 55-58.

Pesteanu, A. 2018. Influence of gibberellic acid GA_{4+7} on the fruiting and quality of apple cultivar Golden Delicious. *Stiinta Agricola*. **2**:43-49.

Stephenson, A.G. 1981. Flower and fruit abortion:proximate causes and ultimate functions. *Annual Review of Ecology and Systematics*,**12**:253-279.

Taylor, D.R. and Knight, J.N. 1986. Russeting and cracking of apple fruit and their control with plant growth regulators. *ActaHortic*.,**179**: 819-820.

Ward, D.L.; Marini, R.P. and Byers, R.E. 2001.Relationships among day of year of drop, seed number, and weight of mature apple fruit. *Hort. Science*, **36**(1): 45-48.

Zhang, X.; Tong, J., Bai, A.; Liu, C.; Xiao, L. and Xue, H. 2020. Phytohormone dynamics in developing endosperm influence rice grain shape and quality. *J. of Integrative Plant Biology*. **62**(10): 1625-1637.