International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(5): 1537-1539
© 2017 IJCS
Received: 26-07-2017
Accepted: 27-08-2017

Ejaz Ahmad Parray
Division of Fruit Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

Munib Ur Rehman
Division of Fruit Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

Tariq A Bhat
Division of Vegetable Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

Ishaq A Bhat
Division of Fruit Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

Muzamil A Hajam
Division of Vegetable Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

Mohammad Asif Wani
Division of Fruit Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

MA Hajam
Division of Fruit Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

Correspondence
Ejaz Ahmad Parray
Division of Fruit Science, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, Jammu and Kashmir, India

Importance of crop load management in apple: An overview

Ejaz Ahmad Parray, Munib UR Rehman, Tariq A Bhat, Ishaq A Bhat, Muzamil A Hajam, Mohammad Asif Wani and MA Hajam

Abstract
To meet market demand and attain profitable fruit production, apple growers must produce fruits of good quality while retaining the highest possible yields. The conflicting nature of these two goals requires accurate management of tree crop load. Excessively low crop loads will lead to reduced productivity, despite a larger fruit size; while, with too many fruits, the yield per tree and per hectare will be reduced. In addition, excessive crop loads can result in alternate bearing in many apple cultivars. Successful fruit production is achieved by maintaining optimum crop load. Crop load management, therefore, is one of most important orchard management techniques used to improve crop yield and quality in apple.

Keywords: fruit production, crop loads, apple

1. Introduction
Crop load is the number of fruits /tree (Francesco *et al*., 1996; Wensche *et al*., 2005) [8]. It is often expressed in terms of number of fruit per trunk cross-sectional area (fruit/TCSA). Too heavy fruit load reduces fruit size and increase crop and vice versa (Mc Artney *et al*., 1996; Treder and Mika, 2001; Treder, 2008) [16, 30, 28]. Most apple cultivars have an over abundant flower density and percentage fruit set (Meland, 2009) [17]. Regulation of crop load is an effective method in apples to improve quality and to prevent biennial bearing (Link, 2000) [15]. Reducing the number of fruits /tree increase relative amount of photo assimilates for the remaining fruit. This also improves flower bud initiation and return bloom, and leads to more consistent annual yield (tromp, 2000) [31]. The consistent production of fruit of optimum color and size can only be accomplished when proper balance between vegetative growth and fruiting is maintained (Reginato, 2002) [24]. Crop has also an impact on the nutrient status of fruits. Irregular cropping results in insufficient nutrient uptake and disharmony of nutrients (Nagy *et al*., 2010) [18]. For this reason, regulation of crop load through thinning is imperative to obtain optimum yield of good quality fruits.

Results and Discussion
Fruit yield
Crop load is the most important factor that influence fruit yield. Low crop load has been found to decrease fruit yield (Palmer *et al.*, 1997) [21]. Wertheim (1997) [35], Lepsis and Blanke (2004) [14] and Treder (2008) [28] reported a positive correlation between crop density and yield but negative correlation between crop density and fruit weight. Palmer *et al*. (1997) [21] reported that rate of fruit growth depends primarily on crop load. If the demand for photo assimilates exceeded the amount available early in the season, due to heavy crop load this leads to decreased fruit growth (Lakso *et al*., 1993) [13]. Giuliani *et al*. (1997) [9] reported that too intensive thinning reduces both yield and effectiveness of photosynthesis. Increasing fruit number per TCSA unit decreases the ratio of leaf area to TCSA and consequently, leaf area to fruit, resulting in a demand amount of available assimilates supporting fruit growth (Palmer *et al*., 1991) [20]. Voltz *et al*. (1993) [33] reported that light cropping and thinned trees have less flower bud density and greater fruit set than the heavy cropping trees. Treder (2010) [29] reported that there is positive correlation between crop density and yield. Palmer (1992) [19] reported that increase in crop load resulted in increase in total dry matter yield per unit leaf area and increase in yield efficiency beyond 10fruits/m^2 leaf area in Crispin M.27. Wunsche and Palmer (2000) [36] reported significant difference in yield per tree with varying crop loads.

Fruit size

Of all the factors that influence fruit size, crop load is the most important. Removing of a part of the crop is the most effective way to improve fruit size (Forshey, 1976) [6]. Over-cropping resulted in a very poor fruit size (Jones *et al.*, 1992) [11]. Early removal of fruit results in larger fruit size at harvest (Preston and Quinlan, 1968; Quinlan and Preston, 1968; Jones *et al.*, 1992) [23, 23, 11]. Batjer (1965) [1] suggested that the increase in fruit size was roughly proportional to the crop retained on the tree. However, studies have shown the increase in fruit size was proportionately less than the reduction in fruit set (Batjer and Thomson, 1961; Rogers and Thompson, 1969) [2, 26] or in the number of fruits/tree (Southwick and Weeks, 1949; Way, 1965) [27, 34]. The close relationship between fruit numbers and yield regardless of tree size clearly indicates that this is the dominant factor contributing towards economic yield.

Fruit size is determined by cell number, cell size and intercellular space (Goffinet *et al.*, 1995) [10]. However, cell number, which is determined early in apple development, accounts for most of the variation in fruit size (Pearson and Robertson, 1953) [22], and it can be influenced by previous year's crop load and may reduce the number of cells in the flower receptacles if it is excessive (Bergh, 1992) [5]. When cell division is reduced by fruit competition during the early growth, optimum fruit size is not achieved. Previous results with many cultivars (Southwick and Weeks, 1949; Batjer and Westwood, 1960; Batjer and Thomson, 1961; Way, 1965; Rogers and Thompson, 1969) [27, 3, 2, 34, 26] demonstrated that increase in fruit size were proportionately less than the reduction in fruit numbers. The primary effect of fruit thinning on fruit size is more often a reduction in the number of smaller fruits than a dramatic increase in the size of the remaining fruits (Forshey and Elfving, 1977) [7].

The potential size of a given pome fruit is determined early in the season and growth proceeds at a relatively uniform rate thereafter. This uniform growth rate permits an accurate prediction of the harvest size of the fruit as early as mid-summer (Batjer *et al.*, 1957) [4]. The growth rate, once established, is not easily altered, and fruit numbers, therefore, can affect fruit size only within definite limits and maximum effectiveness requires adjustment in fruit numbers relatively early in the season (Forshey and Elfving, 1977) [7]. Tukey (1970) [32] states, "thinning does not change a potentially small fruit into a large fruit, but rather insures that a potentially large fruit will size properly." Emphasis should be on estimating fruit numbers rather than fruit size. Fruit thinning can quickly reach the point of diminishing returns. Rather than a high percentage of large fruits, the objectives of thinning should be the elimination of the smallest fruits, improved fruit quality and annual production (Forshey and Elfving, 1977) [7]. Koike and Ono (1998) [12] reported that crop load management by thinning is the most important step in order to harvest large, unique sized fruit. They reported that reducing initial fruit set of apples by eliminating a proportion of flowers during the bloom period is usually a highly desirable practice for improving fruit size in apple. Robinson *et al.* (2009) [25] showed that fruit size was reduced by increasing crop load in a curvilinear relationship. They found that fruit size was reduced rapidly as crop load increased from 0 to about 7 fruits/cm^2 TCSA and reported that to obtain optimum fruit size in Honeycrisp apple crop load of 5-6 fruits/cm^{2}TCSA is required. Wunsche *et al.* (2005) [37] reported that at harvest fruit from light cropping trees were larger in size than in heavy cropping trees.

Conclusion

Crop load is the most important of all factors that influence fruit size, and removing of a part of the crop is the most effective way to improve fruit yield and fruit quality. Rather than a high percentage of large fruits, the objectives of thinning should be the elimination of the smallest fruits, improved fruit quality and annual production. Early removal of potential fruit (blossom thinning) should be used in apple to enhance flower initiation for next year's crop and thus, return bloom. This type of thinning also reduces competition for carbohydrates among fruitlets.

References

1. Batjer LP. Fruit thinning with chemicals. U.S.D.A. Agricultural Information Bulletin. 1965; 289:1-27.
2. Batjer LP, Thomson BJ. Effect of 1-N.Methylcarbamate (Sevin) on thinning apples. Proceedings of American Society of Horticultural Science. 1961; 75:1-4.
3. Batjer LP, Westwood MN. 1-Napthyl N. Methylcarbamate, a new chemical for thinning apples. Proceedings of American Society of Horticultural Science. 1960; 27:1-8.
4. Batjer LP, Billingsley HD, Westwood MN, Rogers BL. Predicting harvest size of apples at different times during the growing season. Proceedings of American Society of Horticultural Science. 1957; 70:46-57.
5. Bergh O. Cumulative effect of time of hand thinning on fruit size of 'Golden Delicious' and 'Granny Smith' apples. South African Journal of Plant and Soil Science. 1992; 9(2):64-67.
6. Forshey CG. Factors affecting the chemical thinning of apples. New York's Food and Life Sciences Bulletin, 1976, 64.
7. Forshey CG, Elfving DC. Fruit numbers, fruit size, and yield relationships in 'McIntosh' apples. Journal of American Society of Horticultural Science. 1977; 102(4):399-402.
8. Francesconi AH, Lakso AN, Nyrop JP, Bacnard J, Denning SS. Carbon balance as a physiological basis for the interactions of European red mire and crop load on 'Starkrimson Delicious' apple trees. Journal of American Society of Horticultural Science. 1996; 121(5):959-966.
9. Giuliani R, Callo-Grappadelli L, Magnanini E. Effect of crop load and apple photosynthetic responses on yield. Acta Horticulturae. 1997; 451:303-307.
10. Goffinet MC, Robinson TL, Lakso AN. A comparison of 'Empire' apple fruit size and anatomy in unthinned and hand-thinned trees. Journal of Horticultural Science. 1995; 70:375-387.
11. Jones KM, Bound SA, Koen TB, Oakford MJ. Effect of timing of hand thinning on the cropping potential of 'Red Fuji' apple trees. Australian Journal of Extension and Agriculture. 1992; 32:417-420.
12. Koike H, Ono T. Optimum crop load for Fuji apples in Japan. Compact Fruit Tree. 1998; 31(1):1-9.
13. Lakso AN, Corelli Grappadelli L. Implications of pruning and training practices to carbon partitioning and fruit development in apple. Acta Horticulturae. 1993; 332:231-240.
14. Lepsis J, Blanke M. Forecast of trunk cross section area in the intensive apple orchards as a basis for modeling of fruit yield. Acta Horticulturae. 2004; 654:205-212.
15. Link H. Significance of flower and fruit thinning on fruit quality. Plant Growth Regulators. 2000; 31:17-26.

16. Me Artney S, Palmer JW, Adams HM. Crop loading studies with Royal Gala and; Breabum apples; effect of time and level of hand thinning. New Zealand Journal of Crop and Horticultural Science. 1996; 24:401-407.
17. Meland M. Effects of different crop loads and thinning times on yield, fruit quality and return bloom in *Malus* x *domestica* Borkh. 'Elstar'. Journal of Horticultural Science and Biotechnology, 2009, 117-121.
18. Nagy PT, Szabo Z, Soltesz M, Nyleki J. Effects of irregular cropping on nutrient uptake and status of apple trees. International Journal of Horticultural Science. 2010; 16(1):41-44.
19. Palmer JW. Effects of varying crop load on photosynthesis, dry matter production and partitioning of Crispin/M.27 apple trees. Tree Physiology. 1992; 11:19-33.
20. Palmer JW, Cai YL, Edjama Y. Effect of part-tree flower thinning on fruiting, vegetative growth, and leaf photosynthesis in Cox's Orange Pippin' apple. Journal of Horticultural Science. 1991; 66(3):319-325.
21. Palmer JW, Giuliani, Adams HM. Effect of crop load on fruiting and leaf photosynthesis of Bracbum/M.26 apple trees. Tree Physiology. 1997; 17:741-746.
22. Pearson JA, Robertson RN. The physiology of growth in apple fruits. IV. Seasonal variation in cell size, nitrogen metabolism and respiration in developing granny smith apple fruits. Australian Journal of Biological Science. 1953; 6:1-20.
23. Quinlan JD, Preston AP. Effects of thinning blossom and fruitlets on growth and cropping of sunset apple. Journal of Horticultural Science. 1968; 43:373-381.
24. Reginato GM. Theoretical quantitative approximation of density of plantations and determination of behavior of apple orchards. Revista Fruiticola. 2002; 23(3):93-96.
25. Robinson T, Lopez S, Lungerman K, Reginato G. Crop load management for consistent production of honeycrisp apples. New York Fruit Quarterly. 2009; 17(1):24-28.
26. Rogers BL, AH Thompson. Chemical thinning of apple trees using concentrate sprays. Journal of American Society of Horticultural Science. 1969; 94:24-25.
27. Southwick FW, Weeks WD. Chemical thinning apples at blossom time and up to four weeks from petal fall. Journal of American Society of Horticultural Science. 1949; 53:143-147.
28. Treder W. Relationship between yield, crop density coefficient and average fruit weight of 'Gala' apple. Journal of Fruit and Ornamental Plant Research. 2008; 16:53-63.
29. Treder W. Crop loading studies with 'Jonaglod' apple tree. Journal of Fruit and Ornamental Plant Research. 2010; 18(1):59-69.
30. Treder W, Mika A. Relationship between yield crop density coefficient and average Fruit weight in 'Lobo' apple trees under various planting systems and irrigation treatments. Horticultural Technology. 2001; 11(2):248-254.
31. Tromp J. Flower-bud formation in pome fruits as affected by thinning. Plant Growth Regulators. 2000; 31:27-34.
32. Tukey RB. Predicting the harvest size of Bartlett pear. Washington State University Extension Publishers East Mailing. 1970; 3403:1-7.
33. Voltz RK, Ferguson IB, Bowen JH, Watkins CB. Crop load effects on fruit mineral nutrition, maturity, fruiting and tree growth of 'Cox's Orange Pippin' apple. Journal of Horticultural Science. 1993; 68(1):127-137.
34. Way DW. Carbaryl as a fruit thinning agent. 11 Condition and time of application. Journal of Horticultural Science. 1965; 42:355-365.
35. Wertheim SJ. Useful differences in growth vigour between subclones of the apple rootstock, M.9. Acta Horticulturae. 1997; 451:121-128.
36. Wunsche JN, Palmer JW. Effects of crop load on fruiting and gas- exchange characteristics of Braebum/M.26 apples trees at full canopy. Journal of American Society of Horticultural Science. 2000; 125(1):93-99.
37. Wunsche JN, Greer DH, Laing WA, Palmer JW. Physiological and biochemical leaf and tree responses to crop load in apple. Tree Physiology IS, 2005, 1253-1263.