CHAPTER II

REVIEW OF LITERATURE

Pruning is the art and science of cutting away a portion of the tree to improve its shape, to influence its growth, flowering and fruiting, to improve the quality of the fruit or to repair injury.

Crop load, as a measure of orchard productivity is defined as the amount (e.g.- Number or weight) of fruit produced per tree or branch unit. Assessing crop load is essential in making appropriate management decision to achieve the best fruit size. It provides an indication of whether a heavy, medium or light crop is expected. In pomegranate, crop load is inversely related to fruit size. This simply means the higher the number of fruits the smaller the fruit size. Crop load is largely responsible for the year to year variation in fruit size.

Pomegranate does not require pruning except for the removal of the suckers, dead and diseased branches and for developing a frame work. One of main cause of poor bearing in the commercial orchard is the failure of timely removal of these shoots. The fruits are borne terminally or on short spurs produced all along the slow growing mature wood. These bear fruits for 3-4 years. Only a limited pruning of the bearing tree is therefore required (Singh, 1969). Dutta (1965) suggested that annual pruning during dormant period in winter should be confined to shortening of the previous season growth to encourage fruiting. For securing shapely tree with a good crop, a set of new shoots should be allowed to develop every year on all sides of the tree and gradual growth of new shoots should be encouraged by restricted cutting back of bearing shoots. It should be borne in mind that shortening of older wood is likely to reduce the yield but not the quality. Patil and Karale (1985) suggested pruning of old spurs to encourage growth of new ones.

The spurs in pomegranate have the capacity to bear fruits for 3-4 years and they decline in production with advance in age (Karale, 1995).

Sheikh (2006) reported that pruning was have following effects.
1. Fruitful and differentiated buds are located at the distal portion of the branches.
2. Pruning of terminal portion of branch would lower down the total flower production.
3. Pruning does not affect sex ratio and fruit quality in pomegranate.
4. Pruning significantly affects total fruits, marketable and unmarketable. Fruits and yield of higher grade fruits are more with intensity of pruning.
5. Pruning and less fruit load minimizes the bending and also the staking.
6. Higher intensity of pruning is not detrimental to vegetative growth of plants.

Crop load is a key cultural component of final fruit quality and thus of managing the risks associated with achieving commercial requirements for fruit size, consumer based quality attributes, and freedom from disorder. In this regard crop load is important in enhancing the proportion of the crop achieving desired qualities.

Palmer et al. (1997) suggested that in apple the thinning or crop load practice is necessary to maximize crop value and tree performance and also reported that the adoption of crop load management is having a more number of advantages, of which two are particularly important,

1. Decreasing yield, thereby increasing mean fruit weight and acceptable market quality.
2. Achieving improved net return bloom and consistent annual yields.

Byer (2003) reported that optimized crop load for a given cultivar and production system in a particular environment can give enhanced financial returns to growers in apple.

2.1 Effect of severity of pruning and crop load on vegetative growth

2.1.1 Effect of severity of pruning and crop load on plant height

Kumar and Srivastava (1982) reported that the height of the tree was significantly reduced under control when compared with light pruning and moderate pruning. The observation of spread of trees was more in moderate pruning in apple.

Devi and Haribabu (1986) revealed that the maximum height and spread was found in pruning with 4-6 nodes from the base of tree in ber crop.
Nath (1994) revealed that in Assam lemon the plant growth with respect to tree height and spread of the tree were increased with the severity of pruning.

Sharma et al. (1997) concluded that the effect of pruning intensities on the production of kinnow mandarin in the most crowded part (East-West) direction i.e. (tree within the row) of the tree responded to pruning with the initiation of profuse vegetative growth, the possible reason of more growth in E.W. direction is the maximum availability of space and light for growth and development of the tree.

Lal et al. (2001) reported that the canopy spread (E-W and N-S) was recorded greater in unpruned than pruned tree but the pruning of branches having a more effect on canopy spread in mango cv. Dasheri.

Porwal and Nagde (2003) reported that maximum plant height and plant spread were recorded at light pruning treatment. Increased vegetative growth under light treatment might be due to more supply of metabolites towards growing shoots which resulted into increase height and number of shoots which ultimately enhanced the spread of plants in rose.

Myriam et al. (2005) reported that the vegetative growth enhancement caused by severe pruning was likely to stimulate leaf to fruit ratio compared to light pruning for a same fruit load on the peach tree.

Lal and Mishra (2008) observed that the mango tree height responses more to pruning of branches existing on main trunk compared to unpruned tree. Ervin (1979) also made same observations.

2.1.2 Effect of severity of pruning and crop load on production of new shoots

Several research workers have reported that due to pruning, the new shoots emerge earlier.

Gopikrishana (1979) observed that pruning at 8 cm and 25 cm levels had an adverse effect on new shoots production in guava.

Pandey (1998) observed the maximum number of primary shoots in 25% pruning, while significantly higher number of secondary and tertiary shoots at 50% pruning intensity in ber.
Bhattacharya et al. (1999) revealed that the production of new shoots was markedly influenced by pruning of 30.48 cm (12 inch) branches with fruiting panicle in litchi.

Lal et al. (1999) conducted experiment on a 45 year old Dashehari tree the effect of various pruning severities revealed that the growth of emerging shoot was significantly influenced by the severity of pruning.

Roberto and Jonathan (2000) reported that selective pruning have more production of new vegetative shoot and panicles. However, panicles and shoots were greater when branches pruned during July and September in kiwi fruit.

Shiekh and Rao (2002) reported that the number of shoots per branch in pomegranate was significantly higher with mild pruning than severe pruning as compared to unpruned tree and there was no significant difference in respect of number of shoots per branch with different crop load, irrespective of severity of pruning.

Kumar (2002) noted that pruning intensity in ber had a great effect on the production of primary, secondary and tertiary branches. The maximum number of primary branches was found under 25 and 50 % pruning, whereas number of secondary and tertiary branches was highest under 50% pruning intensity.

Chandal et al. (2004) concluded that the heavily pruned vines attained significantly higher shoot growth and produced more pruning wood and vegetative shoots as compared to lightly pruned vines. The maximum shoot growth and number of vegetative shoots per cane was recorded in severely pruned vine having a bud load of 25 canes with 6 buds/cane in kiwi.

Kumar and Reddy (2004) reported that in ber the pruning of branches to six secondaries have higher sprouting percentage thus the pruning back to previous season growth, pruning half of branches and pruning to major limbs this is mainly because of pruning here was medium and it has not affected the good reserve for sprouting of buds and also percentage of sprouting was better.
2.1.3 Effect of severity of pruning and crop load on length of new shoot

Several research reports have revealed that pruning operation increased growth of shoot in many fruit crops.

Sharma *et al.* (1997) reported that in peach the longest annual shoot (35.0 cm) was recorded in trees subjected to 400 fruiting nodes (26-27 fruiting shoots/tree) followed by 500 fruiting nodes (33-34 fruiting shoots/tree) treatments.

Wunsche and Pahner (1997) investigated a range of “Braeburn/ m-26” apple tree growth responses to various crop load levels and found that non fruiting trees load significantly longer and thicker diameter shoots.

Rathi *et al.* (2003) noted that the shoot length and thickness was significantly influenced by various pruning intensities. Maximum increase in shoot length as well as its thickness was recorded in the most heavily pruned tree (60% pruning) than lightly and medium pruned trees of peach.

Singh and Nautiyal (2005) opined that the maximum increase in the shoot length as well as its girth were more in the most heavily pruned tree (75% pruning) than the light (15% and 30%) and medium (45% and 60%) pruning in apple.

Mohammed *et al.* (2006) stated that shoot length was appreciably increased with the increasing level of pruning (15cm, 30cm and 60cm) and 30 and 60 cm pruning levels were generally effective in increasing the number of leaves/shoot in guava cv. Lucknow-49.

Shaban (2009) concluded that in guava, the length of new shoots increased on severely pruned shoots (pruning of 50% old shoot) than moderate (pruning of 25% old shoot) or pinching or the unpruned tree. Similarly, Bajpai *et al.* (1973) reported that increased in shoot length by severe pruning in guava.

Shaban (2009) reported that a significant increase in length of new developed flushes with all pruning treatment (light pruning of 5cm, moderate pruning of 30 cm) compared to unpruned one. The highest value of new flushes length was recorded with moderate pruning in Zebda mango trees.
2.1.4 Effect of severity of pruning and crop load on leaf area

Pruning has profound effect on leaf area.

Gopikrishna (1979) noted that by severe pruning of guava branches there was a marked increased in leaf area. Similarly, Gupta and Godra (1988) reported that in ber the maximum leaf area was recorded with severity of pruning.

Kumar and Srivastava (1982) noted that pruning in apple cv. Royal Delicious increased leaf area.

Schupp et al. (1992) reported that the crop load having significantly greater leaf area for non fruiting than fruiting apple tree. Petrie et al. (2000) found similar effects of fruiting on leaf area and shoot growth in grape.

Bankar et al. (2000) concluded that in ber the severe pruning induced more growth in respect of leaf area. Similar finding was also reported by Bharas (1997).

Lal et al. (2000) reported that the reduction in leaf area was observed with full shoot pruning in guava.

Wunshe and Cakso (2000) opined that reducing the number of fruit per tree inevitably increased the leaf area per fruit resulting in increased availability of as similarity to the remaining fruits in apple.

Shiekh and Rao (2002) noted that the pruning and fruit load showed highest leaf area with severe pruning (30 cm) than mild one (15 cm) in pomegranate.

2.2 Effect of severity of pruning and crop load on flowering

2.2.1 Effect of severity of pruning and crop load on number of flower/shoot

Flowering has been found to be induced by pruning in many fruits. In sweet lime (Citrus limethiodes) Arora and Yamdagni (1985) reported that the average number of flower per shoot were maximum in tree which were subjected to medium pruning intensity and it was significantly higher as compared to severe pruning levels.

Buzzard and Schwabe (1995) found that heavily cropping 27 years old “Cox”s orange “Pippin” apple trees had fewer number of flowers clusters per tree,
small flowers and lower initial fruit set in the subsequent spring than tree that were defruited in the previous season.

In an experiment, when 20 years old Dhashehari mango tree was improved with pruning treatments, maximum shoot came to flowering (37%) in heading back of terminal branches at 50 cm followed by 27.5 % in removal of weak criss-cross branches (Anon., 1999).

Nanthakumar et al. (1999) reported that the medium level of pruning (75 cm) resulted in more number of flower and highest percentage of bisexual flower which could favorably leads to higher yield in ber.

Khan and Syamal (2004) observed that in kagzi lime the effect of pruning on flowering have significantly more on the production of flowers and they showed that the maximum number of flower per branch were recorded under medium (30 cm) while minimum number of flower per branch recorded in unpruned trees.

Sharma and Singh (2006) reported that sex ratio were significantly influenced by pruning severity, canopy height, the sex ratio were observed to be lighter in unpruned (control) tree and lower in severely pruned tree followed by moderately pruned one in mango.

Lal and Mishra (2007) observed that in mango cv. Chausa the higher flowering was observed in tree which received heading back up to tertiary branches.

2.3 Effect of severity of pruning and crop load on quality

2.3.1 Effect of severity of pruning and crop load on fruit size or diameter

Pruning has both beneficial and adverse effects on fruit size.

Lal and Thakur (1978) reported that increased fruit size of Santa Rosa plum trees by thinning the flowers at petal face stage by hand or by chemical.

Tomita and Natsumi (1978) found in citrus tree that when fruit were thinned to leaves 83 to 92 leaves per fruit there was a superior fruit growth and they further observed that better fruit growth of citrus hassaka by thinning to one fruit
per 53 leaves compared to no thinning.

Anon. (1982) reported that fruit size in Muscat pomegranate progressively increased when the number of fruit per tree decreased.

Amma et al. (1986) reported that removal of 2-3 terminal has immediately after the female phase improved individual finger size, thus improving bunch grade and enhanced marketability in banana.

Bergh (1990) revealed that late thinning of apple cultivar compared to early thinning progressively reduce fruit size when similar number of fruit were present on tree. Thinning of individual apple cluster to one or two fruit resulted in larger fruit than de fruiting whole bunches removing whole clusters or no thinning.

Ray and Worley (1991) reported that pruning generally increased nut size over the unpruned tree when measured as percentage of nuts in size category, increasing the intensity of pruning tended to increase nut size in pican.

Sheikh and Hulmani (1993) reported that level of 30 and 60 cm pruning resulted into significant increase in fruit size (length and breadth) and fruit weight in guava.

Lakso (1994) reported that in apple high crop densities during the early growth period of fruit cell division may cause a deficit in carbohydrate availability to the developing fruit that ultimately can lead to decreased fruit growth rate and reduces the final fruit size. Similar finding was also reported by Johnson (1992) that severity of thinning of fruit has a marked influence on fruit size in apple.

Prakash and Nauotiyal (1996) succeeded that the fruit size and quality increased with the increase in the intensity of pruning in peach. Similar finding was reported by Badiyala and Awasthi (1989)

Sheikh (1999) concluded that in pomegranate the highest diameter of fruit was noted in severe pruning (30 cm pruning) as compared to mild one (15 cm) as against unpruned tree and significant difference was noted in relation to fruit load. The highest diameter was noted with 30 fruit load as against the control.
Cheema et al. (2003) reported that the increasing in the berry size of grape was observed with cluster thinning and berry thinning.

Singh and Daliwal (2004) found out that pruning in general, resulted in a progressive increase in fruit size with severity of pruning in Sardar guava. However the increase in fruit size in terms of length and breadth may be attributed to the reduction in crop load, which in turn diverted more nutrients to the remaining fruit thereby improving the size of fruits.

Singh et al. (2004) observed that the effect of amount of pruning in ber with respect to fruit size in term of length and breadth increased with the severity of pruning (pruning at 8 buds level) the large fruits in heavy pruned trees were due to their less number per trees.

2.3.2 Effect of severity of pruning and crop load on fruit weight

Singh (1969) reported that pruning of guava increased fruit weight, fruit length, fruit diameter in cultivar Allahabad Safeda and Sardar. Similar finding was reported by Mohd kaisar (1989) that the fruit weight was maximum with mild pruning in Navalar guava.

Martinez (1988) reported that the thinning of fruits in four year old papaya plants, increased the weight of individual fruits. The enhanced fruit weight of plum with early thinning by removing 60 % of the fruit (Betmans and Keualemman, 1987).

Smith and Gallott (1990) reported that thinning of peach fruit by removing 44 to 54 % of the fruit increased kernel percentage of Mohawk and Shoshoni varieties.

Hand thinning experiments with 3 levels of thinning treatment viz., 30, 49 and 54 % of the fruit lets in Satsuma orange gave increased proportion of fruit in too larger grade with thinning severity (Sutton and Harty, 1990).

Sheikh (1999) concluded that the highest fruit weight was recorded with severe pruning with 30 fruit load as against mild pruning with 50 fruit load in
Review of literature

Ganesh pomegranate.

Miller et al. (2001) observed that the average fruit weight on leader pruned (removal of all vigorous upright shoots) vines were consistently greater which translated into an improvement in yield in kiwi fruit.

Salanke et al. (2006) reported that pruning in grape cv. Thompson seedless have a marked affect on berry size and weight. However the mild pruning gives maximum bunch weight.

Somkumar et al. (2006) reported that maximum bunch weight was recorded when 75 per cent of total length of cluster was retained and berries in a bunch were thinned as compared to the control where no cluster clipping and berry thinning was performed. The maximum berry weight was recorded in 75 per cent cluster retention and berry thinning treatment as compared to control in grape.

Shaban (2009) reported that moderate pruning significantly increased fruit weight compared to control while severe pruning gave slight effect on fruit weight it may be due to increasing number of fruit per tree under sever pruning in Zebda mango.

2.3.3 Effect of severity of pruning and crop load on hundred aril weight, rind thickness and fruit rind percentage

Pareek and Godra (1993) reported that with all fruit per tree in pomegranate 100 g aril weight having 207.60 grain, 20 fruit per tree having 188.30 grain where in 50 fruits per tree having 157.88 grain.

Hussein et al. (1994) reported that hand thinning of flower and with sevin and NAA in pomegranate increased fruit weight but reduced the peel percentage compared to un thinned one.

Nath (1994) reported that as the intensity of pruning increased the percentage of pulp were increased significantly but there was reduction in peel percentage in lemon.
Sharma et al. (1997) observed that the thickness of peel in case of kinnow mandarin was marginally increased in pruned tree compared to unpruned one.

Sheikh (1999) observed that pruning and crop load has helped in reduction of rind thickness. The thinnest rind of 2.3 mm was noted by mild pruning with 40 fruit load and different fruit load treatment increased the rind percentage as compared to unpruned tree of pomegranate cv. Ganesh

2.3.4 Effect of severity of pruning and crop load on juice percentage

Facik (1977) reported that the increase in size and juice percentage could be due to more leaf area per tree and ultimately cause the more photosynthesis for better fruit development in grape fruit.

Arora and Yam Dagni (1985) observed that the tree under medium intensity of pruning were bigger size and higher in juice percentage compared to severely pruned and unpruned trees in sweet lime.

Pareek and Godra (1993) reported 49 % juice with 20 fruit tree and 44 % juice in other treatments per tree. However, difference among the treatment was non-significant in pomegranate.

Nath (1994) concluded that a considerable change in the quality of fruit with respect to percentage of pulp and juice. As the intensity of pruning increased the percentage of pulp and juice were increased significantly in assam lemon.

Sheikh (1999) reported that there was significant difference in respect of juice percentage between mild and severe pruning. The highest juice percentage was noted with 50 fruit load followed by 40 fruit load. Hence the highest percentage of juice recorded by mild pruning with 50 fruit load in pomegranate.

2.4 Effect of severity of pruning and crop load on physical parameters

2.4.1 Effect of severity of pruning and crop load on fruit set and fruit drop

Several Research worker have observed that pruning generally results
in improved fruit set.

Bajpai et al. (1973) observed minimum flower drop by severe pruning (100 cm pruning) but maximum flower drop on mildly pruned (30 cm pruned) branches in guava.

Gopikrishana (1981) observed that minimum flower drop in severely pruned (25 cm of pruning) branches as compared to unpruned branches in guava.

Arora and Yamdagni (1985) concluded that pruning of trees significantly increased fruit set as compared to unpruned one. Induction of flower significantly higher with both medium and severe pruning over the unpruned could be due to increased flower brought out by pruning intensities in sweet orange.

Mukunda and Thimmaraja (1989) reported that in case of Alphonso, fruit set is confined mostly to the tip of the inflorescence. Thinning out the panicles gave fruit set at secondary branch retained at the bottom of the inflorescence. However, maximum fruit set at the secondary branches of the panicle was noticed.

In case of Santa Rosa plum, 75 % heading back results higher fruit set and fruit weight, no heading back results poor fruit set with poor fruit yield. (Kumar et al., 1992)

Mishra and Pathak (1998) concluded that the pruning treatment induced significantly more number of flower, fruit set and fruit retention in Lucknow-49 guava.

Dhillon (2004) observed that the pruning of 4 buds per cane in grape vine gave highest fruit bunches retention and highest fruit yield.

Pedro et al. (2004) concluded that the pruning of red raspberry increased fruiting nodes and fruit number percentage.

Waghmare and Joshi (2008) concluded that in mango the regulation of vegetative phases, pruning up to 2.5 cm was found more effective with the application of 2.5 cm pruning. There was significantly maximum fruit set per panicle and fruit retention resulted into maximum fruit yield.
Shaban and Haseeb (2009) concluded that pruning treatment significantly increased initial fruit set over the unpruned tree. The highest fruit set was recorded with moderate pruning and severe pruning in guava.

2.4.2 Effect of severity of pruning and crop load on days to maturity

Mayuoni-Kirshenbaum and Porat (2015) observed in order to standardize minimum maturity indices for harvest of the early-season pomegranate cultivar ‘Acco’, fruits were evaluated to know the quality parameters at 10-day intervals during the last period of the ripening process. It was found that slight changes only in peel and aril colour, juice, total soluble solids and acid contents were observed with gradual increase in fruit and aril weights during the last stage of ripening.

2.4.3 Effect of severity of pruning and crop load on fruit cracking percentage/plant

Singh et al. (2011) reported that Fruit drop (%), fruit cracking (%) and incidence of diseases (%) was not affected notably with various deblossoming treatments including the control.

2.4.4 Effect of severity of pruning and crop load on damage fruit percentage by bacterial blight

Raju (2010) reported that disease incidence in pomegranate of bacterial blight was less in hast bahar compared to mrig bahar. Hence, it is advisable on pomegranate.

Sharma et al. (2011) reported that hast bahar during the September-October result in less disease incidence.

Benagi et al. (2012) reported that taking up pruning in month of September minimize infection of bacterial blight in pomegranate orchards as during pruning infested twigs get removed reducing disease inoculum in orchard.
2.4.4 Effect of severity of pruning and crop load on damage fruit percentage by annar caterpillar

None of the earlier workers found significant relation between pruning and incidence of annar caterpillar (*Deudorix isocrates*) but several workers mentioned that clipping of calyx cap after pollination prevents egg load of pest and minimize pest infestation by Cocuzza *et al.* (2016), Thomas and Prakas (2015).

2.5 Effect of severity of pruning and crop load on fruit yield

*Amma et al.* (1986) reported that removal of two or three terminal hands immediately after female phase improved individual finger size, thus improving bunches grade and enhanced marketability in banana.

*Goswami et al.* (1993) reported the yield in citrus could be increased by removing the upright branches and encouraging the horizontal ones by pruning.

*Sheikh* (1999) observed that maximum yield of 12.92 kg was obtained with severe pruning with 50 fruit load as compared to lowest fruit load in pomegranate.

*Pratap et al.* (2003) reported that the fruit yield was reported maximum under moderate pruning followed by severe and light pruning treatment while minimum yield was under control. This improvement in yield may be due to the reduction in vegetative growth caused by light to moderate pruning treatment compared to control in Amarpali mango.

*Chandel et al.* (2004) observed that the higher number of bearing shoots per cane in lightly pruned vines (9 buds per cane), ultimately lightly pruned tree produce maximum yield in kiwi fruit.

*Dhillon* (2004) concluded that in perlette grape the vine pruned to 4 buds per cane produce significantly more number of bunches than 2 buds per cane pruned vine. However, the heights yield 18.9 kg per vine was recorded with 4 buds long canes followed by 3 buds and 5 buds treatment.

*Khan and Symal* (2004) observed that in kagzi lime the maximum yield
of fruit per branch and per tree was recorded under medium pruning followed by severe and light pruning treatment. While minimum yield per branch and per tree was recorded under control (unpruned) trees subject to the heavy pruning recorded low yield as compared to medium pruned tree. This might be due to reduced shoot area in severely pruned tree and the interval between the period and fruiting was short enough to enabling the remaining shoot to improve their vigour and fruiting. Earlier Leyva et al. (1998) also found that moderate pruning increased the yield in lemon in orange.

Singh et al. (2004) reported that the cumulative fruit yield was noted highest from the trees pruned at 16 buds level from the trees pruned at 16 buds level followed by 8 buds. The result revealed that the fruit yield decreases with the severe pruning in guava. Bajwa and Sarawa (1977) also observed that total yield was decreased by severe pruning in ber.

Myriam et al. (2005) concluded that in peach the highest fruit yield and the lowest average fruit weight being achieved with light pruning. However, increasing fruit load stimulated fruit yield from 5-9 kg/tree with 60 fruit to 18.7 kg/tree with 420 fruits. On the contrary, average fruit weight decreased from 60 to 270 fruit/tree (166 to 132 g) and from 270 to 420 fruit/tree (132 to 105 g). These trends were confirmed by fruit grade partitioning with 60 fruit/tree, more than 90% of the harvest had fruit grade higher than the B-grade category (61 to 67 mm) which are the fruit with the highest marketable value.

Mohammed et al. (2006) reported that the yield was recorded sufficiently better in pruning treatment. The maximum yield (131.8 kg/tree) was obtained at 60 cm closely followed by 30 cm pruning (131.0 kg/tree) and minimum (81.1 kg/tree) in control in guava cv. Lucknow-49.

2.6 Effect of severity of pruning and crop load on bio-chemical parameter of fruits

2.6.1 Effect of severity of pruning and crop load on total soluble solids

According to Morioka (1988) fruit thinning in 15 years old Satsuma
mandarin tree increased brix reading of the juice.

Sheikh (1999) observed that the mild and severe pruned tree produced fruit with high total soluble solid compared to control in pomegranate. Pareek and Godara (1993) opined that in pomegranate with increased number of fruit load the total soluble solid depleted.

Sheikh et al. (1996) reported the total soluble solid increased with severity of pruning. Similar finding was reported by Gopikrishna (1979) in guava.

Kumar and Reddy (1997) opined that the alternate pruning in phalsa have more affect on TSS. However, the total soluble solid increased significantly with the increased severity of pruning. Plants pruned to ground level (100 cm previous year pruning) gave sweeter fruits.

Sharma et al. (1997) concluded that total soluble solid in fruit were statistically higher in maintaining of fruit shoot at 40 fruit and 33-34 fruit throughout the tree canopy.

Sharma et al. (1997) reported that the practices like berry thinning and crop load management improved the TSS content significantly in peach.

Swaroop et al. (2001) observed that the pruning in mango cv. Deshehari was significantly increased total soluble solid compared to unpruned trees.

Kumar et al. (2006) reported that the total soluble solid were maximum 24\textsuperscript{0} brix at a pinching level of 4 buds and developing 2 sub cane and maintaining a leaf area of 2200-2400 cm\textsuperscript{2} in grape.

Kumar et al. (2006) stated that the chemical qualities of ber fruit influenced up to some extent by pruning intensity. It was found that the total soluble solid were found better in 60 cm pruning.

Feza Ahmad (2008) reported that the total soluble solid was recorded with 5 buds per cane where as 12 canes per vine gave highest TSS and maximum acidity in himrod grape.
McDonnell et al. (2008) reported that higher crop load increased the brix level for wine quality which is more acceptable for processing of wine and delaying in ripping of carbernet sauvignon grape.

### 2.6.2 Effect of severity of pruning and crop load on titrable acidity

Gopikrishana (1979) concluded that there was no marked influence of pruning on many of the chemical constituents of fruit such as titrable acidity in guava.

Sutton and Harty (1990) reported that hand thinning of Satsuma mandarin by removing the fruit lets did not affect the brix acid ratio.

Nath (1994) reported that the acidity was increased with the decrease in the severity of pruning and highest acidity was recorded under control. Low acidity in fruits under severely pruned tree would have been due to more leaf area per unit which resulted better synthesis and greater translocation of carbohydrate from leaves to fruit in Assam lemon.

Tough et al. (1998) reported that the improvement in total soluble solid and titrable acidity is associated with thinning of fruits which also improves taste and appearance in apple.

Bhattacharya et al. (1999) concluded that the acidity of litchi fruit decreased with severity of pruning excepting pruning 30 cm along with fruiting panicle in litchi.

Chougule et al. (2006) reported that the canopy management in grape significantly reduces acidity. The maximum acidity was recorded in cane density 35 per vine and leaf density 16 per cane after October pruning.

Fanasca et al. (2007) reported that in tomato the citric acid content was significantly reduced by reducing the number of fruits per plant.

### 2.6.3 Effect of severity pruning and crop load on TSS: Acidity Ratio

Awadhwal (1968) reported that higher percentage of TSS and acid sugar:
acid ratio and low acidity found when pruning of vine in month of late January but early pruning resulted in lower TSS, acid sugar : acid ratio in grape.

Godana (1971) reported that the pruning has significantly increases the TSS: acidity ratio of grape. However, the maximum TSS: acidity ratio was found in berries from the vines of pruned on 20th September.

Chahill et al. (1980) reported that in peach hand thinning and chemical (Ethephon - Sevin) thinning treatment were significantly effective in increasing TSS and TSS: Acidity ratio.

Sharma et al. (1997) reported that the pruned tree was marginally higher in TSS: acidity ratio over unpruned one in peach.

Sheikh (1999) reported that there is marginal increase in TSS: Acidity ratio in pruned trees in pomegranate.

Swaroop et al. (2001) concluded that the pruning in July and August increased the TSS: Acid ratio in Dashehari mango.

Singh and Dutt (2002) concluded that the thinning treatment on kinnow fruit increased TSS : Acidity ratio as compared to control. This increase ratio can be ascribed to reduce acid and solid level in thinning treated trees.

2.6.4 Effect of severity of pruning and crop load on sugars

Matsumot and Koroda (1982) observed increase in sugar content of Japanese persimmon by thinning to one fruit per shoot.

Nath (1994) concluded that in assam lemon there was increase in total sugar content up to 30 cm pruning beyond which the content of sugar was declined. The work carried out by Gopikrishna and by several other worker has revealed that with increasing of pruning the sugar content of fruit was increased in fruit like guava.

Sheikh et al. (1996) reported that the total sugar showed no significant difference due to pruning. Non reducing sugar content decreased with mild pruning
and showed no such variation when branches were pruned severely in pomegranate.

Bhattacharya et al. (1999) revealed that an increase in the total sugar content of litchi fruit obtained with increase in the severity of pruning. The pruning of 15.24 cm branches along with fruiting panicle gave maximum total sugar content.

Sheikh (1999) revealed that effect of pruning and fruit load on reducing sugar, total sugar showed significant difference irrespective of crop load and severity of pruning. The highest total sugar was recorded with severe pruning as compared to mild pruning and control. The highest total sugar was observed with 30 fruit load in pomegranate.

Chandal et al. (2004) reported that the higher sugar content as a result of increase in pruning severity in kiwi. Similar finding was reported by Ibrahim et al. (1996) who also obtained higher sugar content in heavily pruned vines in grape.

2.6.5 Effect of severity of pruning and crop load on ascorbic acid

Sheikh (1999) reported that there was no significant difference in ascorbic acid content with respect to pruning and crop load in pomegranate.

Singh and Dhaliwal (2004) reported that a significant increase in ascorbic acid with increased in the severity of pruning in guava.

2.7 Effect of severity of pruning and crop load on economics

Koujalagi (1990) reported that the total cost of cultivation of pomegranate per orchard was 5,932.45 and per acre it was Rs. 2,887.93. The major contribution to the total cost of cultivation of pomegranate was labour cost. It amounted to 1,235.85 (42.79%) per acre. The cost incurred on fertilizers (552.70) and manure (405.65) were the next major item of cost forming 19.14 % and 14.05 % of the total cost of cultivation. The other items of costs contributing to the total cost of cultivation were cost of plant protection chemical (9.43%), irrigation charge (3.74%) and land revenue (0.14%).

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Richardson and McAnenry (1990) revealed that using the approach of optimised fruit weight which corresponds to a crop load of approximately 50 fruit. The information can be used by grower to develop pruning and thinning strategies that maximize return rather than yield and also by industry to set price schedules that encourage the production of fruit in the most marketable size range of kiwi fruit.

Waskar (1996) reported that the cost of packaging and transportation comes to 40-42% when marketing of fruits is done by an individual farmer, on the contrary it accounts to 32-35% when it is done through co-operative societies in Sangola of Solapur district.

Chitra et al. (1997) in the study on economic of ber production in and around Hyderabad city of Andhra Pradesh found that, the total cost of establishments in 1st year were Rs 7,713 per hectare. The total cost incurred during the maintenance was 3,483 per hectare during the total cost of cultivation worked out to 1,61,737 per hectare.

Hiremath et al. (1997) concluded the research work on economic evaluation of lime (Citrus aurantifolia) cultivation in Bijapur district, Karnataka. That the per hectare total maintenance cost was 69852.38 in small, 32655.13 in medium and 306586.53 in large orchard. The high cost incurred by small orchard owners indicated the intensive practice followed by them for lime. The maintenance cost of lime in different size group during bearing period showed among the variable cost, the labour cost accounted chunk share (more than 65%) in all the size group of orchard. The reason in quite obvious that, in most of the perennial horticultural crops most of the operation was carried out through labourers and there is very less scope for mechanization.

Rao et al. (1997) concluded study of profitability of mango cultivation in drought prone area of Anantpur district of Andhra Pradesh. The result of economic analysis indicated that the annual maintenance cost i-e from fourth year on words worked out to be 5,169 per hectare. The cost of production per hectare of mango garden was 17,828 and the gross return realized from the output of mango worked out to 22,083 per hectare. The net return obtained from the output was
16,194 per hectare.

Kumar et al. (1999) summarized that the total cost of cultivation of gherkins was 29,837.30 per acre. The total variable cost amounted to 23,738.40 and fixed cost 6,098.90 of the total cost. The fertilizers and FYM accounted 11.36 percent (3390.00). Gherkin is a labour intensive crop requires regular operation like weeding, training, plant protection measure. More than 50 % of labour is engaged in harvesting and handling of the produce and chemical to control the pest and disease which constitute 5–86 % of the total costs. The average yield obtained of tones per acre valued 48000.00. The net income was worked out to 18162.70.

Shivanand (2002) studies the cost and return structure in banana in north Karnataka and concluded that cultivation of banana in the study area was highly profitable and on an average banana growers obtained net returns of 85,260 per hectare per year which was about 2,61,726 for cycle of three year period.

Matthew and David (2005) reported that the improvement in fruit size by “S” (every second spur, spur - thinned) and “B” (every second flower, blossom thinned) thinning increased estimated crop value per kg. (69 % and 95 %) as compared to “C” (manual removal of 50 % blossoms), respectively but the production economics would be favourable for “S” (every second spur, spur thinned) due to lower costs to harvest fewer fruit per tree. In contrast, “B” improved crop, value per tree by 52 % compared to “C”. This increase translate to about $ 9265 per hectare at a tree density of 840/ha. This preliminary economic analysis clearly favours “B” vs. “S” fruit and greater improvement in fruit size from “B” compared to “S” in novel sweet cherry crop.

Mohammed et al. (2005) reported economics of guava crop with various pruning treatments revealed that 30 cm pruning gave maximum profit 1,52,400 per hectare which was closely followed by 60 cm pruning (1,48,300 per hectare) and it was minimum (1,33,200 per hectare) in control.
Sefo et al. (2006) in their study on economics of production of wine grape on eight family farmers in 2001 and 2002 in Canton region included the analysis of the most important results of grape production viz. total crop production, total production cost, worth of production, realization cost and profitability co-efficient. In 2002, the production value increased by 33.1 per cent compared to that of in 2001, the increase is the result of an insignificant growth in crop production and significant increase in the selling price. In total production cost, direct expenses were 87 – 90 per cent and indirect were 10 – 13 per cent per family farm. The selling prices have shown a tendency of growth.