The Pharma Innovation Journal 2022; 11(9): 381-390

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(9): 381-390

www.thepharmajournal.com
Received: 03-06-2022
Accepted: 07-07-2022

Narendra Ramteke
Ph.D. Scholar, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Dr. SG Bharad
Ph.D. Scholar, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Dr. PK Nagre
Associate Dean, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Dr. SR Patil
Professor, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Dr. UA Raut
Associate Professor, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Karan Jadhav
Ph.D. Scholar, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
Narendra Ramteke
Ph.D. Scholar, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Effect of planting density and fruit load on fruit yield and quality of custard apple

Narendra Ramteke, Dr. SG Bharad, Dr. PK Nagre, Dr. SR Patil, Dr. UA Raut and Karan Jadhav

Abstract
An investigation was carried out to study the "Effect of planting density and fruit load on fruit yield and quality of custard apple." The experiment was laid out in Factorial Randomized Block Design with three spacing levels 4 x 4 m, 4 x 2.5 m and 3 x 3 m and five levels of fruit load (fruit retention). Fruit retention up to 100 per plant, Fruit retention up to 80/plant, Fruit retention up to 60 per plant, Fruit retention up to 40 per plant and No fruit thinning (control) fifteen treatment combinations replicated thrice. The fruit retention in varying quantities as per treatments was imposed after 15 days from fruit development when fruits were Anola size. It is evident from the experimental findings that, in terms plant height was found highest under the treatment spacing 4 x 2.5 m as well as fruit retention 60 per plant. Whereas, the plant spread and plant volume under the treatment spacing 4 x 4 m as well as fruit retention 60 per plant. The flowering time in terms of days from pruning to first flower bud initiation was observed in the treatment spacing 4 x 4 m as well as fruit retention 60 per plant. Leaf area and chlorophyll contents were observed in the treatment spacing 4 x 2.5 m as well as fruit retention 60 per plant. The fruit yield parameters like number of graded fruits per plant and weight of fruits found highest under the treatment spacing 4 x 2.5 m as well as fruit retention 60 per plant.

Keywords: Spacing, fruit load, plant density, pruning, thinning, flowering, yield

Introduction
Custard apple (*Annona squamosal* L.) a native of tropical America is the most favourable fruit crop in India under the family Annonaceae and has got a pleasant flavour, mild aroma and sweet taste which have a universal acceptance. It is popular by virtue of its spontaneous spread in forest, waste lands, rocky slope and other uncultivated places, its nutritional value and wide uses in processing industries as well as in manufacturing bio-pesticides. Custard apple is an arid fruit crop and hardy in nature requires dry climate with mild winter. It is proving boon to the arid zones of Maharashtra because of their wider adaptability, comparatively freeness from pests and diseases, hardy nature, known to thrive under diverse soil and climatic conditions and also escape from stray and grazing animals. Custard apple is one of the finest fruits gifted to India by tropical America and West Indies. In India, the custard apples are very popular in Deccan plateau and are grown commercially on smaller scale in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Uttar Pradesh, Tamil Nadu, Assam, Karnataka and Orissa. Maharashtra and Andhra Pradesh are the leading states in Annona cultivation as well as annual production. In 2017, the area and production of custard apple in Maharashtra is (9,424 Ha), (65,968 Mt) respectively which is 64.45 per cent of total area and 64.49 per cent of total production in India (Hiwale S. 2015) [8]. The productivity of custard apple in Maharashtra is 2.87 production / Ha (Anonymous, 2015) [1].

Due to large tree canopy, the traditional system of custard apple cultivation has often posed problems in obtaining desired fruit productivity per unit area. Therefore, there is need of changing production system in custard apple by manipulating its natural plant canopies. Currently, there is a worldwide trend of higher density planting to control tree size and maintained desired architecture for higher productivity. Better light interception and improved microclimatic conditions in the orchard and within the plant canopy not only improved the productivity but improves the quality of fruit and reduce the stress of pest and disease. So, that the high density recharging facilitates enhance production and quality of fruits by managing the plant canopies in the different ways. There is a shift in farmers' insight from production to productivity and profitability which can be achieved through high density planting. Recently, there is a trend to plant fruit trees at closer spacing leading to high density orchard.

Now a day's high-density planting is a new approach in custard apple cultivation in Maharashtra. The traditional cultivation of custard apple was made on 6 x 6 m or 5 x 5 m wide spacing but due to high density planting the farmers of Vidarbha are planting their custard apple orchard on 4 x 4 m, 4 x 3 m, 3 x 3 m and 4 x 2.5 m. There are good growth and better fruiting in close spacing along with summer pruning having drip irrigation. Due to high density planting fruit yield per unit area is more in custard apple (Anonymous, 2018) [1]. HDP results in overcrowding, over lapping not only in the tops, but also in the root system and heavy competition for space, nutrients and water. It induces precocity, increases yield and improves fruit quality.

Thinning increases fruit size, increases the annual yield of marketable fruit, improve the colour of fruit, improve the quality of fruit (T.S.S), fetching good market price reduces the limb breakage and promotes general tree vigor and ensure more regular cropping. For production of economical yield of custard apple fruits, it is necessary to adopt a proper agro-technique by applying new cultural practices like standard cultural practices, training, pruning, thinning, growth regulators, nutrition, plant density etc. are most important for production of vegetative growth, flowering, fruit yield and quality yield. The growth and flowering of Custard apple are greatly influenced by different spacing and fruit load like 60 fruits per plant and 80 fruits per plant.

Material and Methods

The field experiment entitled "Effect of planting density and fruit load on fruit yield and quality of custard apple" cv. Balanagar "was conducted at farmers field of Shri. Vinayji Bothra at Dhanaj (Khurd), Tq-Karanja, Distt. Washim (Maharashtra State) during the year 2018-19 and 2019-20. And analytical work of the experiment was carried out at Analytical Laboratory, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2018-19 and 2019-20. Ten-year-old custard apple healthy plants of uniform growth of cultivar Balanagar were selected from the custard apple plantation of Shri. Vinayji Bothra's field at Dhanaj, Taluka Karanja, Distt. - Washim for experimentation.

The experiment was conducted in Factorial Randomized Block Design (FRBD) with 15 treatment combination which were replicated thrice and number of plants per treatment was five. The custard apple orchard was well established which was planted before ten years at different spacing in different block of the same field. The spacing of the custard apple blocks are S1: 4.0 m x 4.0 m, S2: 3.0 m x 3.0 m and S3: 4.0 m x 2.5 m while thinning or fruit retention per plot asT_1: Fruit retention up to 100/plant, T_2: Fruit retention up to 80/plant, T_3: Fruit retention up to 60/plant, T_4: Fruit retention up to40/plant and T_5: No fruit thinning. The custard apple field irrigated regularly during the period of investigation. The irrigation schedule was suggested as per the critical water requirements period of crop i.e., of flowering, fruit setting and fruit development stage.1st irrigation was given at flowering in the 1st week of July. Ploughing was done to break the dormancy and to keep up the soil loose and check weed growth in root. The custard apple field was kept weed free by regular weeding and also with the help of tractor operated tractor moulded implements. Fertigation schedule was followed during both the years of experimentation. Pruning was done in the last week of May, spraying of Bordo mixture after pruning was done. The growth hormones NAA was sprayed for control the flower and fruit dropping in the month July and August. Thinning was done when custard apple fruits had attained Anola size and it was done as per the treatment combination in the first week of September. Five plants of each treatment were selected, marked and kept under observations for recording various observations. The detail observations recorded from planting spacing and fruit load.

Result and Discussion

The result obtained from present investigation are presented below on the basis on the pooled mean of two year of experimentation.

Growth Parameters

The observations regarding the effect of planting density and fruit load on fruit yield and quality of growth characters of custard apple *viz*., plant height, plant spread, plant volume, days for flowering, leaf area and chlorophyll content are presented in Tables 1 and 2.

Effect of plant density on plant height

The data regarding the growth parameters of custard apple was significantly influenced by the different spacing and fruit retention during both the years of experimentation.

Data presented in Table 1 revealed that, the spacing 4 x 2.5 m recorded highest plant height (3.01 m and 3.10 m) which was significantly superior than rest of all the treatments during the year 2019 and 2020. This was followed by the spacing 4 x 4 m (2.89 m and 3.00 m). However significantly lowest plant height (2.78 m and 2.88 m) was recorded by the spacing 3 x 3 m.

Similarly pooled mean of two years data for significantly highest plant height (3.05 m) shown in spacing 4 x 2.5 m followed by the spacing 4 x 4 m (2.94 m) and lowest plant height (2.83 m) was recorded by the spacing 3 x 3 m.

The data presented in Table 1 indicated that closer spacing of 4 x 2.5 m recorded maximum height. It was noticed that, too close planting tended to increase plant height because of close planting very little space is left for spread of plant. In addition to this, in closer spacing plant grows taller in search of light and this condition might have resulted in more apical growth at the expense of lateral growth (Sharma *et al*., 1980 and Mohammed *et al*., 1984) [37, 38]. The present results are in conformity with the findings of Sidhu *et al*., (1992) [28], Rajput *et al*., (2004) [23], Kundu (2007) [14] and Singh *et al*., (2007) [31] in guava.

Effect of fruit load on plant height

Data presented in Table 1 revealed that, the treatment fruit retention 60 per plant recorded highest plant height (3.07 m and 3.16 m) which was significantly superior than rest of all the treatments during the year 2019 and 2020 and followed by the treatment fruit retention 80 per plant (2.96 m and 3.06 m), fruit retention 100 per plant (2.88 m and 2.98 m) and fruit retention 40 per plant (2.82 m and 2.92 m) during both the years of experimentation. Whereas, in the treatment control i.e., no fruit thinning the significantly lowest plant height was noted (2.74 m and 2.84 m).

Similarly pooled mean of two-year data for highest plant height (3.11 m) shown maximum in treatment fruit retention 60 per plant which was significantly superior than rest of all the treatments followed by the treatment fruit retention 80 per

plant (3.01 m), fruit retention 100 per plant (2.93 m) and fruit retention 40 per plant (2.87 m). However, significantly lowest plant height was observed in the treatment no fruit thinning (2.79 m).

In custard apple the wider spacing reduced tree height while it increases the plant spread and plant volume due to greater availability of light and space and these observations corroborated with the findings obtained by Brar *et al.* (2012) [5] in guava.

Effect of plant density and fruit load on plant spread

The results regarding plant spread are presented in Table 2. The data revealed that, these were significant differences with respect to plant spread as affected by different plant spacings and fruit load.

Effect of plant density on plant spread

Data presented in Table 1 revealed that, in 2019 significantly maximum plant spread were noticed in spacing 4.0 x 4 m (1.86 m and 1.92 m) followed by spacing 4 x 2.5 m (1.54 m and 1.57 m). However, minimum plant spread was noticed in spacing 3 x 3 m (1.44 m and 1.47 m) during both the years of experimentation.

Similarly pooled mean of two-year data for the significantly maximum plant spread were noticed in spacing 4 x 4 m (1.90 m) whereas pooled mean for the minimum plant spread were noticed in spacing 3 x 3 m (1.46 m).

The data presented in Table 1 showed that, plant spread was more in plants under wider spacing of 4 x 4 m. Maximum mean plant spread recorded under wider spacing might be due to fact that, in wider spacing individual plant gets optimum growth factors such as light, nutrients and water in comparison to closer spacing. Mitra and Bose (1990) [17] and Kundu (2007) [14] also observed greater spread of crown at low planting density in guava. Similar results also obtained by Yadav *et al*., (1981) [35], Sidhu *et al*., (1992) [28], Bal and Dhaliwal (2003) [3], Singh *et al*., (2007) [31] and Ravishankar *et al*. (2008) [24] in guava and Arora *et al*. (1983) [2] in Kinnow.

In custard apple the wider spacing reduced tree height while it increases the plant spread and plant volume due to greater availability of light and space and these observations corroborated with the findings obtained by Brar *et al.* (2012) [5] in guava.

Effect of fruit load on plant spread

Data presented in Table 1 revealed that, the treatment fruit retention 60 per plant recorded maximum plant spread (1.68 m and 1.70 m) which was significantly superior than rest of all the treatments followed by the treatment fruit retention 80 per plant (1.64 m and 1.67 m), fruit retention 100 per plant recorded plant height (1.59 m and 1.65 m) and the treatment fruit retention 40 per plant (1.60 m and 1.1.63 m) during the year 2019 and 2020 of experimentation while in the treatment no fruit thinning significantly lowest plant spread (1.55 m and 1.61 m) was observed. The treatment fruit retention 60 per plant (1.68 m and 1.70 m) and fruit retention 80 per plant (1.64 m and 1.67 m) are significant and statistically at par. Also, treatment fruit retention 100 per plant (1.59 m and 1.65 m) and fruit retention 40 per plant (1.60 m and 1.63 m) are significant and statistically at par.

Similarly pooled mean of two-year data, it is revealed that, the maximum plant spread recorded in the treatment fruit retention 60 per plant (1.69 m) which was significantly superior than rest of all the treatments followed by the treatment fruit retention 80 per plant (1.67 m) and the treatment fruit retention 40 per plant (1.64 m) while in the treatment no fruit thinning significantly lowest plant spread (1.58 m) was observed. The treatment fruit retention 60 per plant (1.69 m) and fruit retention 80 per plant (1.67 m) are significant and statistically at par. Also, treatment fruit retention 100 per plant (1.63 m) and fruit retention 40 per plant (1.64 m) are significant and statistically at par.

From the data presented in Table 1 it revealed that with decrease in crop load, plant spread also shows increasing trend. The tree having maximum spacing with minimum fruit load had the maximum plant spread. It might be due to the fact that optimum availability of light, proper aeration, which increase leaf area and increase the length of shoots and branches. These results are also in conformity with Zhu *et al*. (2015) [36] in olive.

Interaction effect

Data presented in Table 1 revealed that, an interaction effect of plant spread influenced by spacing and fruit load was found to be significant during both year experimentations.

The maximum plant spread recorded in the spacing 4 x 4 m with the treatment fruit retention 60 fruit per plant S1T3 (1.98 m and 2.00 m) followed by the treatment fruit retention 80 per plant S1T2 (1.93 m and 1.96 m) and by the treatment fruit retention 100 per plant S1T1 (1.85 m and 1.95 m) and are significant and statistically at par during both year experimentations. While lowest plant spread recorded in the spacing 3 x 3 m with the treatment no fruit retention S3T5 (1.40 m and 1.45 m) followed by the treatment fruit retention 100 per plant S3T1 (1.40 m and 1.44 m) were found at par during both year experimentations.

Similarly, the two years pooled data for maximum plant spread recorded in the spacing 4 x 4 m with the treatment fruit retention 60 fruit per plant (1.99 m) followed by the treatment fruit retention 80 per plant (1.99 m) and by the treatment fruit retention 100 per plant (1.91 m) and are significant and statistically at par. While lowest plant spread recorded in the spacing 3 x 3 m with the treatment no fruit retention (1.42 m) followed by the treatment no fruit retention (1.43 m) and both are significant and statistically at par.

From the data presented in Table 1 it revealed that by increasing the plant spacing with decrease in fruit load, plant spread also shows increasing trend. The tree having maximum spacing with minimum fruit load had the maximum plant spread. It might be due to the fact that optimum availability of light, proper aeration, which increase leaf area and increase the length of shoots and branches. These results are also in conformity with Zhu *et al*. (2015) [36] in Olive.

Effect of plant density and fruit load on plant volume

The results regarding plant volume are presented in Table 3. The data revealed that, these were significant differences with respect to plant volume as affected by different plant spacing and fruit load treatments under study.

Effect of plant density on plant volume

The results regarding plant volume are presented in Table 3. The data revealed that the spacing 4 x 4 m recorded significantly highest plant volume (21.09 m^3 and 23.26 m^3) followed by the spacing 4 x 2.5 m (14.87 m^3 and 16.09 m^3) which was significantly superior than rest of all the treatments

during both the year of experimentation. However, significantly lowest plant volume was recorded by the spacing 3 x 3 m (12.03m^3 and 12.99 m^3).

Similarly pooled mean of two years data for plant volume recorded significantly highest plant volume in the spacing 4 x 4 m (22.18 m^3) followed by the spacing 4 x 2.5 m (15.48 m^3) while recorded significantly lowest plant volume in the spacing 3 x 3 m (12.51 m^3).

Maximum canopy volume was observed in wider spacing of 4 x 4 m. During the experimentation, the branches of the plants grown in closer spacing had overlapped which might be having the shading effect thereby leading to reduced synthesis of photosynthates as well as reduced uptake of moisture and nutrients from the soil which ultimately affect the plant growth (Arora *et al*., 1983) [2]. Kumar and Singh (2000) [11] showed decreasing trend of tree canopy volume with the increasing tree density in guava. The above results are in conformity with Sidhu *et al*., (1992) [28] and Ravishankar *et al.* (2008) [24] in guava.

Effect of fruit load on plant volume

The results regarding effect of fruit load on plant volume are presented in Table 3. The data revealed that the treatment fruit retention 60 per plant recorded highest plant volume (18.45 m^3 and 19.48 m^3) which was significantly superior than rest of all the treatments during the year 2019 and 2020 and followed by the treatment fruit retention 80 per plant recorded plant volume (16.99 m^3 and 18.13 m^3), fruit retention 100 per plant recorded plant volume (15.44 m^3 and 17.43 m^3) and fruit retention 40 per plant (15.19 m^3 and 16.54 m^3). Whereas, in the treatment control i. e., no fruit thinning significantly lowest plant volume (13.92 m^3 and 15.65 m^3) was recorded in both the years of experimentation. Meanwhile, the treatment fruit retention 80 per plant recorded plant volume (18.13 m^3) and fruit retention 100 per plant recorded plant volume (17.43 m^3) during second year a of experimentation are significant and statistically at par.

Similarly, pooled mean of two-year data for plant volume observed highest plant volume (18.97 m^3) which was significantly superior than rest of all the treatments during the year 2019 and 2020 and followed by the treatment fruit retention 80 per plant recorded plant volume (17.57 m^3), fruit retention 100 per plant recorded plant volume (16.44 m^3) and fruit retention 40 per plant (15.87 m^3). Whereas, in the treatment control i. e., no fruit thinning significantly lowest plant volume (14.78 m^3) was recorded.

In custard apple the wider spacing reduced tree height while it increases the plant spread and plant volume due to greater availability of light and space and these observations corroborated with the findings obtained by Brar *et al.* (2012) [5] in guava.

Interaction effect

Data presented in Table 1 revealed that, an interaction effect of plant volume influenced by spacing and fruit load was found to be significant during both year experimentations.

The data revealed that, highest plant volume was recorded in the spacing 4 x 4 m with the treatment fruit retention 60 per plant (25.10 m^3 and 26.54 m^3) followed by the treatment fruit retention 80 per plant (23.17 m^3 and 24.68 m^3), the treatment fruit retention 100 per plant (20.60 m^3 and 23.76 m^3) and the treatment fruit retention 40 per plant (19.06 m^3 and 21.27 m^3) while the lowest plant volume was recorded in the spacing 3 x 3 m with the treatment no fruit retention (10.86 m^3 and 11.92 m^3) during both the year of experimentation. Meanwhile, the plant volume was recorded in the spacing 4 x 4 m with the treatment fruit retention 100 per plant (20.60 m^3 and 23.76 m^3) and the treatment fruit retention 80 per plant (23.17 m^3 and 24.68 m^3) are statistically at par. Also, the plant volume was recorded in the spacing 4 x 2.5 m with the treatment fruit retention 40 per plant (14.49 m^3 and 15.62 m^3) and the treatment no fruit retention (13.35 m^3 and 14.92 m^3) are statistically at par during both the year of experimentation.

Similarly pooled mean of two-year data for the highest plant volume was recorded in the spacing 4 x 4 m with the treatment fruit retention 60 per plant (25.82 m^3) followed by the treatment fruit retention 80 per plant (23.92 m^3), the treatment fruit retention 100 per plant (22.19 m^3) and the treatment fruit retention 40 per plant (20.16 m^3) while the lowest plant volume was recorded in the spacing 3 x 3 m with the treatment no fruit retention (11.42 m^3).

Meanwhile, the plant volume was recorded in the spacing 4 x 4 m with the treatment fruit retention 100 per plant (22.19 m^3) and the treatment fruit retention 80 per plant (23.92 m^3) are statistically at par. Also, the plant volume was recorded in the spacing 4 x 2.5 m with the treatment fruit retention 40 per plant (15.06 m^3) and the treatment no fruit retention (14.14 m^3) was found at par.

Maximum canopy volume was observed in wider spacing of 4 x 4 m with fruit load 60 per plant. During the experimentation, the branches of the plants grown in closer spacing had overlapped which might be having the shading effect thereby leading to reduced synthesis of photosynthates as well as reduced uptake of moisture and nutrients from the soil which ultimately affect the plant growth (Arora *et al*., 1983) [2]. Kumar and Singh (2000) [11] showed decreasing trend of tree canopy volume with the increasing tree density in guava. The above results are in conformity with Sidhu *et al*., (1992) [28] and Ravishankar *et al.* (2008) [24] in guava.

In custard apple the wider spacing reduced tree height while it increases the plant spread and plant volume due to greater availability of light, space and due to optimum fruit load plant received maximum nutrients for increasing the plant volume and these observations corroborated with the findings obtained by Brar *et al.* (2012) [5] in guava.

Effect of plant density and fruit load on flowering time

Effect of plant density on flowering time

The results regarding flowering time (in days from pruning) are presented in Table 4. The data revealed that the spacing 4 x 2.5 m recorded minimum flowering time in days from pruning (32.40 days and 33.53 days) which was significantly superior and statistically at par with the spacing 4 x 4 m (33.00 days and 34.07 days) during the year 2019 and 2020. However, significantly maximum flowering time in days from pruning (34.60 days and 35.20 days) was recorded by the spacing 3 x 3 m.

Similarly pooled mean of two years data for flowering time from pruning (32.97 days) was recorded in spacing 4 x 2.5 m which was significantly superior and statistically at par with the spacing 4 x 4 m (33.53 days).

The lowest flowering time in days might be due to more uptake of nutrients from soil and accumulation in leaf tissues which enhance the leaf area and contain more chlorophyll. The results of present finding are agreement with the finding of Pilania *et al.* (2010) [22] and Dahapute *et al.* (2018) [6] in

custard apple.
High temperature cause denaturation of enzymes affecting the metabolic processes that in turn affects plant growth adversely. On the other hand, removal of the terminal bud through pruning helps in breaking of apical dominance and enhances translocation of auxins to the lateral bud to develop new bud. (Islam *et al*., 2006) [39].
The early flowering might be due to high density planting which stimulates flowering and fruit production as availability of nutrients are in sufficient quantities of the plant to carry out their metabolic and physiological processes. These findings are in accordance with results reported by Patil (1987) [20] in Ber, Pawar (1993) [40] in Pomegranate and Adhikari *et al*., (2015) [41] in Kagzi lime.

Effect of fruit load on flowering time
The results regarding effect of fruit load on flowering time (in days from pruning) are presented in Table 2. The data revealed that, the treatment fruit retention 60 per plant recorded minimum flowering time in days from pruning (32.00 days and 32.89 days) which was significantly superior and statistically at par with the treatment fruit retention 80 per plant and fruit retention 100 per plant during the year 2019 and 2020. Also, the treatment fruit retention 40 per plant recorded at par with the treatment no fruit thinning.
Similarly pooled mean of two-year data for lowest flowering time in days from pruning (32.44 days) was recorded in treatment fruit retention 60 per plant which was significantly superior and statistically at par with the treatment fruit retention 80 per plant (32.72 days) and fruit retention 100 per plant (33.67 days). However, significantly highest flowering time in days from pruning (35.72 days) was observed in the treatment no fruit thinning which was statistically at par with the treatment fruit retention 40 per plant (34.44 days).
The lowest flowering time in days might be due to more uptake of nutrients from soil and accumulation in leaf tissues which enhance the leaf area and contain more chlorophyll. The results of present finding are agreement with the finding of Pilania *et al.* (2010) [22] and Dahapute *et al.* (2018) [6] in custard apple.
Heavy fruit load trees initiate flowering later as comparison to light fruit load trees and the new vegetative growth was delayed. Low fruit load trees started new vegetative growth immediately and almost the entire amount of carbohydrates, which otherwise would form flower buds, might have been utilized in the vegetative growth of trees resulting in a delayed flowering low fruit load trees (Dhaliwal and Singh 2004) [42] in guava.

Interaction effect
The results regarding flowering time (in days from pruning) are presented in Table 4. The data presented in Table 2 revealed that, an interaction effect of plant density and fruit load on flowering time in days from pruning was found to be non-significant during both year experimentations.

Effect of plant density and fruit load on leaf area
Effect of plant density on leaf area
The results regarding leaf area are presented in Table 2. The data revealed that, the maximum leaf area (41.88 cm^2 and 42.87 cm^2) was recorded in treatment of spacing 4.0 m x 2.5 m which was significant and statistically at par with spacing 4.0 x 4.0 m during the year 2019 and 2020. However, significantly lowest leaf area (39.00 cm^2 and 40.04 cm^2) was recorded by the spacing 3 x 3 m.
Similarly pooled mean of two years data for leaf area (42.38 cm^2) was recorded in spacing 4.0 m x 2.5 m which was significant and statistically at par with spacing 4.0 x 4.0 m. Also, significantly lowest leaf area (39.82 cm^2) was recorded by the spacing 3 x 3 m.
The higher leaf area might be due to more uptake of nutrients from soil and accumulation in leaf tissues which enhance the leaf area and contain more chlorophyll. The results of present finding are agreement with the finding of Pilania *et al.* (2010) [22] and Dahapute *et al.* (2018) [6] in custard apple.

Effect of fruit load on leaf area
The results regarding leaf area are presented in Table 2. The data revealed that, the treatment fruit retention 60 per plant recorded maximum leaf area (42.19 cm^2 and 42.75 cm^2) which was significantly superior and statistically at par with the treatment fruit retention 80 per plant (41.44 cm^2 and 42.11 cm^2) recorded during both the years of experimentation. And fruit retention 100 per plant recorded leaf area (40.64 cm^2 and 41.22 cm^2) and fruit retention 40 per plant (40.56 cm^2 and 41.56 cm^2). Whereas, in the treatment control the significantly lowest leaf area (40.27 cm^2 and 40.55 cm^2) was recorded.
Similarly, pooled mean of two-year data for highest leaf area (42.38 cm^2) was recorded in treatment fruit retention 60 per plant and statistically at par with the treatment fruit retention 80 per plant. However, significantly lowest leaf area (39.78 cm^2) was observed in the treatment no fruit thinning.
The higher leaf area might be due to more uptake of nutrients from soil and accumulation in leaf tissues which enhance the leaf area and contain more chlorophyll. The results of present finding are agreement with the finding of Pilania *et al.* (2010) [22] and Dahapute *et al.* (2018) [6] in custard apple.
The maximum leaf area (42.38 cm^2) was recorded in treatment fruit retention 60 per plant as the number of fruits are optimum. If the number of fruits increases per plant, then the leaf area is decreases. Nii (1997) [18] also reported that leaf area in peach at fruit maturation stage decreased with increasing numbers of peaches fruits per plant. Palmer (1997) [19] reported in apple that leaf area increased with lighter crop load. A higher leaf area might be due to more number of leaves which produce more assimilates, its accumulation in leaf tissue enhances the leaf area.

Effect of plant density and fruit load on chlorophyll content
Effect of plant density on chlorophyll content
The results regarding chlorophyll content are presented in Table 2. The data revealed that, the spacing 4 x 2.5 m recorded highest chlorophyll content (69.67 nm) which was significantly superior than rest of all the treatments during the year 2019 while chlorophyll content (70.80 nm) in the spacing 4 x 4 m was statistically at par with the spacing 3 x 3 m (69.20 nm) in the second year 2020.
Similarly pooled mean of two years data for highest chlorophyll content (70.30 nm) was recorded in spacing 4 x 2.5 m followed by spacing 4 x 4 m (68.68 nm) while lowest chlorophyll content (67.53 nm) was recorded in spacing 3 x 3 m.
From the data presented in Table 2 it revealed that with increasing in leaf to decreasing plant spacing, chlorophyll content also shows increasing trend. The tree having

maximum leaf with minimum plant spacing had the maximum chlorophyll content. It might be due to the fact that optimum availability of light, proper aeration, which increase leaf area followed by better photosynthate production. These results are also in conformity with Zhu *et al*. (2015) [36] in Olive.

Effect of fruit load on chlorophyll content

The results regarding chlorophyll content are presented in Table 2. The data revealed that, the treatment fruit retention 60 per plant recorded highest chlorophyll content (73.32 nm and 74.11 nm) which was significantly superior than rest of all the treatments during the year 2019 and 2020 and followed by the treatment fruit retention 80 per plant (68.81 nm and 70.11 nm) and the treatment fruit retention 100 per plant (67.03 nm and 67.78 nm) recorded. Whereas, in the treatment control i.e., no fruit thinning the significantly lowest chlorophyll content (64.56 nm and 66.11 nm) were recorded during the year 2019 and 2020.

Similarly, pooled mean of two-year data for highest chlorophyll content (73.72 nm) was recorded in treatment fruit retention 60 per plant followed by the treatment fruit retention 80 per plant (69.46 nm) and the treatment fruit retention 100 per plant (67.41 nm) recorded. However, significantly lowest chlorophyll content (65.39 nm) was observed in the treatment no fruit thinning.

The highest chlorophyll content and higher leaf area might be due to more uptake of nutrients from soil and accumulation in leaf tissues which enhance the leaf area and contain more chlorophyll. The results of present finding are agreement with the finding of Pilania *et al.* (2010) [22] and Dahapute *et al.* (2018) [6] in custard apple.

The leaf area and chlorophyll content show increasing trend. The tree having maximum leaf had the maximum chlorophyll content and tree having minimum leaf had the minimum chlorophyll content. It might be due to the fact that optimum availability of light, proper aeration, which increase leaf area followed by better photosynthate production. The results are also in conformity with Zhu *et al.* (2015) [36] in Olive.

(II) Physical Quality Parameters

Effect of plant density and fruit load on fruit weight

The data regarding the physical quality parameters i.e., fruit weight of custard apple was significantly influenced by the spacing and fruit load during both the years (2019 and 2020) of experimentation.

Effect of plant density on fruit weight

Data presented in Table 3 revealed that, highest fruit weight (284.92 g and 288.17 g) was noticed in spacing 4.0 x 2.5 m which was significantly superior and statistically at par with the spacing 4.0 x 4.0 m (281.69 g and 284.27 g) during the year 2019 and 2020. However, significantly lowest fruit weight (266.87 g and 270.00 g) was recorded in the spacing 3.0 x 3.0 m.

Similarly, pooled mean of two-year data for the highest fruit weight (286.84 g) was recorded in the spacing 4.0 x 2.5 m which was significantly superior and statistically at par with the spacing 4.0 x 4.0 m (282.98 g). While pooled mean of two-year data for the lowest fruit weight (268.43 g) was observed in the spacing 3.0 x 3.0 m.

This is might be due to the closer spacing had higher average weight in relation fruits produced by plants subjected to light pruning with closer spacing and fruit retention. The results of present findings are in agreement with the findings of Mohamed *et al*. (2010) [43] and Dahapute *et al.* (2018) [6] in custard apple.

Effect of fruit load on fruit weight

Data presented in Table 3 revealed that, the treatment fruit retention 60 per plant recorded highest fruit weight (310.79 g and 314.34 g) which was significantly superior than rest of all the treatments during the year 2019 and 2020.

It was followed by the treatment fruit retention 80 per plant having fruit weight (282.74 g and 286.97 g) and the treatment fruit retention 100 per plant having fruit weight (276.48 g and 278.09 g). However, significantly the lowest fruit weight (249.22 g and 252.89 g) was recorded in the treatment control i.e. no fruit thinning followed by the treatment fruit retention 40 per plant (269.89 g and 271.78 g).

Similarly, the pooled mean of two-year data for the highest fruit weight (312.72 g) was observed in the treatment fruit retention 60 per plant while pooled mean of two-year data for the lowest fruit weight (268.43 g) was recorded in the treatment no fruit thinning.

This is might be due to the fruit retention had higher average weight in relation fruits produced by plants subjected with low fruit retention per tree. The results of present findings are in agreement with the findings of Mohamed *et al*. (2010) [43] and Dahapute *et al.* (2018) [6] in custard apple.

Interaction effect

Data presented in Table 3 revealed that, an interaction effect of plant density and fruit load on fruit weight influenced by spacing and fruit load was found to be significant during both year experimentations. However, the highest fruit weight (324.63 g and 327.67 g) was observed in the interaction of the treatment fruit retention 60 per plant with 4.0 x 2.5 m spacing was statically at par with spacing 4.0 x 4.0 m and the treatment fruit retention 60 per plant (321.07 g and 323.67 g) while the treatment fruit retention 80 per plant (285.78 g and 289.67 g) and fruit retention 100 per plant (277.92 g and 278.33 g) were statically at par in the spacing 4.0 x 2.5 m. Likewise spacing 4.0 x 2.5 m with the treatment fruit retention 80 per plant (289.10 g and 292.91 g) and fruit retention 100 per plant (282.18 g and 283.93 g) were statically at par.

However, the pooled mean of two years, the highest fruit weight (329.79 g) was recorded in the spacing 4 x 2.5 m with the treatment fruit retention 60 per plant (329.79 g) followed by the spacing 4 x 4 m with the treatment fruit retention 60 per plant (319.22 g) and the spacing 3 x 3 m having treatment fruit retention 60 per plant (389.17 g) while in the spacing 4.0 x 2.5 m, the treatment fruit retention 80 per plant (287.73 g) and fruit retention 100 per plant (278.13 g) were statically at par. Likewise spacing 4.0 x 2.5 m with the treatment fruit retention 80 per plant (289.10 g and 292.91 g) and fruit retention 100 per plant (282.18 g and 283.93 g) were statically at par.

This is might be due to the fruit retention had higher average weight in relation fruits produced by plants subjected with closer spacing and fruit retention. The results of present findings are in agreement with the findings of Mohamed *et al*. (2010) [43] and Dahapute *et al.* (2018) [6] in custard apple.

(III) Yield Parameters

Effect of plant density and fruit load on fruit yield per plant

The results regarding fruit yield per plantare presented in Table 3. The data revealed that, there were significant differences with respect to fruit yield per plantas affected by different plant spacing and fruit load treatments under study.

Effect of plant density on fruit yield per plant

The results regarding fruit yield per plant are presented in Table 3. The data revealed that, significantly the highest fruit yield per plant were recorded in the plant spacing 4.0 x 2.5 m (20.67 kg and 21.47 kg) which are superior than all the treatments followed by plant spacing 4.0 x 4.0 m (18.40 kg and 19.27 kg) while lowest fruit yield per plant were recorded in the spacing 3.0 m x 3.0 m (17.13 kg and 18.33 kg) in both the years of experimentation.

Similarly pooled mean of two-year data, significantly the highest fruit yield per plant were recorded in the plant spacing 4.0 x 2.5 m (21.07 kg) which is superior than others followed by plant spacing 4.0 x 4.0 m (18.84 kg) while lowest fruit yield per plant were recorded in the spacing 3.0 m x 3.0 m (17.73 kg).

The yield per plant was observed maximum because of optimum balance between the vegetative and reproductive growth of trees and maximum number of fruits increase the yield per plant. In custard apple the flowers and fruits are born on current season growth, a light annual pruning is necessary to encourage new shoots after harvest. High density planting along with pruning also reduces tree crown area and increase number of fruits. The results are in close agreement with the Mohmad *et al*. (2005) [44] in custard apple and Kumar and Rattanpal (2010) [13] in guava, Masalkar and Joshi (2009) [6] and Sheikh and Rao (2002) [27] in pomegranate.

Effect of fruit load on fruit yield per plant

The results regarding fruit yield per plant are presented in Table 3. The data revealed that, these were significant differences with respect to fruit yield per plant as affected by different fruit load treatments under study.

The data presented in Table 3 revealed that significantly highest fruit yield per plant was recorded in treatment of 60 fruit retention per plant (23.00 kg and 23.67 kg) which is superior than all other treatments followed by the treatment of fruit retention 80 per plant (19.88 kg and 20.44 kg) while the lowest fruit yield per plant was recorded in treatment of no fruit retention i.e., no fruit thinning (14.67 kg and 15.89 kg) which was statistically at par with the treatments of fruit retention 40 per plant (15.92 kg and 17.00 kg) in both the years of experimentation.

Similarly pooled mean of two-year data, significantly the highest fruit yield per plant was recorded in treatment of 60 fruit retention per plant (23.00 kg) which is superior than all other treatments followed by the treatment of fruit retention 80 per plant (21.83 kg) while the lowest fruit yield per plant was recorded in treatment of no fruit retention i.e., no fruit thinning (15.89 kg) which was statistically at par with the treatments of fruit retention 40 per plant (17.44 kg).

Reduction in yield with this treatment could be attributed to decrease in number of fruits per tree. Similar findings were also reported by Casierra *et al*. (2007) [45] in peach. Sdoodee *et al.* (2008) [26] reported that the highest yield was found in high crop load in mangosteen trees.

Effect of interaction

Data presented in Table 3 revealed that, an interaction effect of plant density and fruit load on fruit yield per plant was found to be non-significant during both year experimentations while pooled data was found significant.

The pooled mean of two-year data for the fruit yield per plant was recorded in the spacing 4 x 2.5 m with the treatment of fruit retention 60 per plant (24.17 kg) followed by the spacing 4 x 4 m with the treatment of fruit retention 60 per plant (23.17 kg) and the spacing 3 x 3 m with the treatment of fruit retention 60 per plant (21.67 kg) and statistically at par with each other. However, the lowest fruit yield per plant was recorded in the spacing 3 x 3 m with the treatment n fruit retention i.e., no thinning (14.83 kg).

Table 1: Effect of plant density and fruit load on plant height, plant spread and plant volume

Treatments	Plant height (m)			Plant Spread (m)			Plant volume (m^3)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
	Spacing								
S1: 4.0 x 4.0 m	2.89	3.0	2.94	1.86	1.92	1.90	21.09	23.26	22.18
S2: 4.0 x 2.5 m	3.01	3.1	3.05	1.54	1.57	1.57	14.87	16.09	15.48
S3: 3.0 x 3.0 m	2.78	2.88	2.83	1.44	1.47	1.46	12.03	12.99	12.51
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E(m)±	0.017	0.017	0.017	0.001	0.008	0.005	0.218	0.201	0.196
CD 5%	0.050	0.050	0.049	0.025	0.024	0.015	0.634	0.584	0.570
	Fruit Load								
T1: Fruit retention 100/ plant	2.88	2.98	2.93	1.59	1.65	1.63	15.44	17.43	16.44
T2: Fruit retention 80/ plant	2.96	3.06	3.01	1.64	1.67	1.67	16.99	18.13	17.57
T3: Fruit retention 60/ plant	3.07	3.16	3.11	1.68	1.70	1.69	18.45	19.48	18.97
T4: Fruit retention 40/ plant	2.82	2.92	2.87	1.60	1.63	1.64	15.19	16.54	15.87
T5: No fruit thinning	2.74	2.84	2.79	1.55	1.61	1.58	13.92	15.65	14.78
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E(m)±	0.022	0.022	0.022	0.011	0.011	0.007	0.281	0.259	0.256
CD 5%	0.065	0.064	0.064	0.032	0.031	0.019	0.818	0.754	0.736
	Interaction (S X T)								
S1T1	2.88	2.99	2.93	1.85	1.95	1.91	20.60	23.76	22.19
S1T2	2.96	3.07	3.02	1.93	1.96	1.95	23.17	24.68	23.92
S1T3	3.07	3.17	3.12	1.98	2.0	1.99	25.10	26.54	25.82
S1T4	2.81	2.91	2.86	1.80	1.87	1.88	19.06	21.27	20.16

S1T5	2.74	2.85	2.79	1.75	1.83	1.78	17.54	20.04	18.79
S2T1	2.97	3.06	3.02	1.52	1.56	1.56	14.30	15.94	15.12
S2T2	3.06	3.14	3.10	1.55	1.57	1.57	15.39	16.21	15.80
S2T3	3.22	3.31	3.27	1.58	1.60	1.59	16.82	17.74	17.28
S2T4	2.94	3.02	2.98	1.53	1.56	1.56	14.49	15.62	15.06
S2T5	2.84	2.95	2.89	1.5	1.55	1.55	13.35	14.92	14.14
S3T1	2.78	2.89	2.84	1.4	1.44	1.43	11.42	12.60	12.01
S3T2	2.85	2.96	2.91	1.44	1.48	1.48	12.42	13.51	12.97
S3T3	2.91	3.01	2.96	1.48	1.50	1.49	13.42	14.16	13.79
S3T4	2.71	2.82	2.77	1.45	1.47	1.47	12.02	12.74	12.38
S3T5	2.63	2.72	2.68	1.40	1.45	1.42	10.86	11.917	11.42
F test	NS	NS	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E(m)±	0.22	0.038	0.038	0.019	0.019	0.011	0.487	0.449	0.438
CD 5%	--	--	--	0.056	0.054	0.033	1.418	1.307	1.274

Table 2: Effect of plant density and fruit load on flowering time, leaf area and chlorophyll content

Treatments	Flowering time (days from pruning)			Leaf area (cm^2)			Chlorophyll content		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
	Spacing								
S1: 4.0 x 4.0 m	33.00	34.07	33.53	41.20	42.02	41.61	68.17	69.20	68.68
S2: 4.0 x 2.5 m	32.40	33.53	32.97	41.88	42.87	42.38	69.67	70.80	70.30
S3: 3.0 x 3.0 m	34.60	35.20	34.90	39.00	40.04	39.82	66.93	68.13	67.53
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E(m)±	0.435	0.382	0.368	0.328	0.230	0.190	0.377	0.465	0.320
CD 5%	1.267	1.112	1.072	0.676	0.670	0.552	1.10	1.353	0.931
	Fruit Load								
T1: Fruit retention 100/ plant	33.22	34.11	33.67	40.64	41.22	40.93	67.03	67.78	67.41
T2: Fruit retention 80/ plant	32.11	33.33	32.72	41.44	42.11	42.03	68.81	70.11	69.46
T3: Fruit retention 60/ plant	32.00	32.89	32.44	42.19	42.75	42.82	73.32	74.11	73.72
T4: Fruit retention 40/ plant	34.00	34.88	34.44	40.56	41.56	40.78	67.56	68.78	68.22
T5: No fruit thinning	35.33	36.11	35.72	40.27	40.55	39.78	64.56	66.11	65.39
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E(m)±	0.562	0.493	0.475	0.424	0.297	0.245	0.487	0.600	0.413
CD 5%	1.635	1.435	1.384	0.873	0.866	0.713	1.418	1.746	1.202
	Interaction (S X T)								
S1T1	33.0	33.67	33.33	40.33	41.75	41.04	66.77	67.33	67.06
S1T2	32.67	34.00	33.33	41.67	42.49	42.08	68.10	69.33	68.72
S1T3	30.33	31.67	31.00	42.33	43.00	42.67	73.96	74.67	74.31
S1T4	33.67	34.67	34.167	41.00	41.67	41.33	67.67	69.33	68.50
S1T5	35.33	36.33	35.83	40.65	41.17	40.91	64.33	65.33	64.83
S2T1	32.0	33.33	32.67	42.58	42.58	42.42	69.00	70.67	69.83
S2T2	30.67	32.00	31.33	43.67	43.67	43.25	70.33	71.67	71.00
S2T3	32.0	33.33	32.67	43.92	43.92	43.96	74.67	75.33	75.00
S2T4	33.0	34.00	35.50	42.67	42.67	41.83	68.33	68.67	68.67
S2T5	34.33	35.00	34.67	41.50	41.50	40.42	66.00	67.67	67.00
S3T1	34.67	35.33	35.00	39.00	39.33	39.33	65.33	65.33	65.33
S3T2	33.0	34.00	33.50	39.00	40.17	40.75	68.00	69.33	68.67
S3T3	33.67	33.67	33.67	40.33	41.33	41.83	71.33	72.33	71.83
S3T4	35.33	36.00	35.67	38.00	40.33	39.17	66.67	68.33	67.50
S3T5	36.33	37.00	36.67	38.67	39.00	38.00	63.33	65.33	64.33
F test	NS	NS	NS	NS	Sig.	Sig.	NS	NS.	NS.
S.E(m)±	0.973	0.854	0.823	0.519	0.515	0.424	0.844	1.039	0.715
CD 5%	--	--	--	--	---	---	-	--	--

Table 3: Effect of plant density and fruit load on number of fruits and fruit yield per plant

Treatments	Fruit weight (g)			Fruit yield per plant (Kg)		
	2019	2020	Pooled	2019	2020	Pooled
	Spacing					
S1: 4.0 x 4.0 m	281.69	284.27	282.98	18.40	19.27	19.47
S2: 4.0 x 2.5 m	284.92	288.17	286.84	19.59	20.67	21.07
S3: 3.0 x 3.0 m	266.87	270.00	268.43	16.42	17.13	17.73
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E(m)±	1.51	1.51	1.35	0.54	0.33	0.22
CD 5%	4.40	4.39	4.05	1.56	0.98	0.66
	Fruit Load					
T1: Fruit retention 100/ plant	276.48	278.09	277.28	17.22	18.11	18.94

T2: Fruit retention 80/ plant	282.74	286.97	284.85	19.88	20.44	21.83
T3: Fruit retention 60/ plant	310.79	314.34	312.72	23.00	23.67	23.00
T4: Fruit retention 40/ plant	269.89	271.78	270.83	15.92	17.00	17.44
T5: No fruit thinning	249.22	252.89	250.33	14.67	15.89	15.89
F test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E(m)±	1.95	1.95	1.74	0.69	0.43	0.29
CD 5%	5.69	5.67	5.08	2.02	1.27	0.85
	Interaction (S X T)					
S1T1	277.92	278.33	278.13	17.67	19.00	19.83
S1T2	285.78	289.67	287.73	20.00	20.67	21.67
S1T3	321.07	323.67	319.22	23.00	23.67	23.17
S1T4	275.67	278.0	276.83	16.33	17.00	17.17
S1T5	248.00	251.67	249.83	15.00	16.00	15.50
S2T1	282.18	283.93	283.06	18.67	19.67	20.17
S2T2	289.10	292.91	291.00	22.30	23.00	24.83
S2T3	324.63	327.67	329.79	24.00	24.67	24.17
S2T4	274.00	275.33	274.67	17.00	18.33	18.83
S2T5	254.67	261.00	255.67	16.00	17.66	17.33
S3T1	269.33	272.00	270.67	15.33	15.67	16.83
S3T2	272.33	278.33	275.83	17.33	17.66	19.00
S3T3	286.67	291.67	289.17	22.00	22.67	21.67
S3T4	260.0	262.00	261.00	14.43	15.67	16.33
S3T5	245.00	246.00	245.50	13.00	14.00	14.83
F test	Sig.	Sig.	Sig.	NS.	NS.	Sig.
S.E(m)±	3.38	3.37	3.02	1.20	0.75	0.50
CD 5%	9.85	9.82	8.79	--	---	1.48

Conclusions

1. On the basis of results obtained in the present experiment entitled "Effect of planting density and fruit load on fruit yield and quality of custard apple" it may be concluded that, plant growth *viz*., plant height, plant spread, plant volume, leaf area and chlorophyll contents was increased in linear order with planting density and fruit load. The treatment combination of 4.0 x 4.0 m with 60 fruit retention per plant has found most effective in growth parameters *viz*. plant spread and plant volume while the treatment combination of 4.0 x 2.5 m with 60 fruit retention per plant has found most effective in growth parameters *viz*. plant height, flowering time, leaf area and chlorophyll contents. Similarly, fruit yield and yield contributing parameters *viz*., number of fruits per plant, average weight of fruit and graded fruit yield were found superior in treatment combination of 4.0 x 2.5 m spacing with 60 fruit load per plant.
2. Better fruit quality in respect of fruit size, pulp weight and acidity were noted when spacing 4.0 x 2.5 m with 60 fruit retention per plant.
3. Based on overall performance in terms of plant growth, yield, fruit quality and B:C ratio, it can be concluded that, under high density planting (4 x 2.5 m) keeping 60 fruits per plant appears to be best for young bearing custard apple orchard.

References

1. Anonymous. A report on the area and production of custard apple; c2018.
2. Arora RK, Yamadgani R, Chundawat BS. Effect of different spacing on growth, yield and quality of Kinnow-a mandarin hybrid. Prog. Hort. 1983;15(1/2):17-23.
3. Bal JS, Dhaliwal GS. High -density planting studies in guava. Haryana J Hort. Sci. 2003;32(1/20):19-22.
4. Bharad SG, Nagre PK, Kale VS, Gholap SV, Raut UA, Satkar Kuntal. Effect of planting densities on growth, yield and quality of guava cv. L-49 under semi-arid climatic conditions of Vidarbha, Maharashtra, India. Research on Crops. 2017 Sep;18(3):462-467.
5. Brar JS, Dhaliwal HS, Bal JS, Som Pal Singh. Effect of spacing on canopy microclimate, vegetative growth and yield attributes in guava (*Psidium guajava* L.). Journal of Hort. Science. 2012:7(1):41-45.
6. Dahapute VM, Joshi PS, Tayde SA, Nagre PK. Effect of severity pruning on growth, yield and quality of custard apple. International Journal of Chemical Studies. 2018;6(2):1606-1609.
7. Gonzalez M, Cuevas J. Optimal crop load and positioning of fruit in cherimoya (*Annona cherimola* Mill.) trees. Scientia Horticulture. 2008:115(2):129-134.
8. Hiwale S. Sustainable Horticulture in Semiarid dry lands. Springer India; c2015, 135-152p.
9. Jens N, Dennis HG, William AL, John WP. Physiological and biochemical leaf and tree responses to crop load in apple. Tree Physiology. 2005;25(10):1253-1263.
10. Kumar A, Avaste RK, Pandey B, Lepcha B, Rehman H. Effect of fruit load on yield and quality of peach (*Prunnus persica*) in mid hills of Sikkim Himalaya. Indian Journal of agricultural Sciences. 2012:82(3):267-269.
11. Kumar R, Singh HP. Effect of planting systems cum densities on growth, fruit size and yield of guava Allahabad Safeda under rainfed conditions. Ann. Agric. Res. 2000;21(1):152-153.
12. Kumar V, Kumar R, Gupta N, Khajuria S, Singh VB. Scope and importance of custard apple cultivation under rainfed areas. Rashtriya Krishi. 2018:13(1):115-117.
13. Kumar Y, Rattanpal HS. Effect of pruning in guava planted at different spacing under Punjab conditions. Indian Journal Horticulture. 2010:67(Special Issue):115-119.
14. Kundu S. Effect of high density planting on growth, flowering and fruiting of guava (*Psidium guajava* L.). Acta Horticulture. 2007;735:267-270.
15. Maas FM, Steeg PAH. Crop load regulation in

Conference Pears. Acta Horticulture No.909; c2011.
16. Meland M. Effects on 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;84(Special issue):117-121.
17. Mitra SK, Bose TK. Guava, In: Bose, T. K. and S. K. Mitra Eds. The Fruits of India- Tropical and Sub-Tropical, Naya Prakash, Culcutta; c1990, 286-301p.
18. Nii N. Changes of starch and sorbitol in leaves before and after removal of fruits from trees. Annals of Botany. 1997;79(2):139-144.
19. Palmer JW, Giuliani R, Adams HM. Effect of crop load on fruiting and photosynthesis of Braeburn/M26 apple trees. Tree physiology, 1997;17(11):741-746.
20. Patil UM. Effect of pruning intensities on growth, yield and quality of ber (*Zizyphus mauritiana* L.) Cv. Umran. M.Sc. (Agri.). Thesis, MPKV, Rahuri, Maharashtra, India; c1987.
21. Phillips EL. Thinning peaches. V.P.L. Circ., 1965, 874.
22. Pilania Shalini AK, Shukla LN, Mahawer, Rajvirsharma, HL Bairwa. Standardization of pruning intensity and integrated nutrient management in medow orcharding guava Indian J Agric. Sci. 2010;80(8):115-117.
23. Rajput SG, Shinde NN, Patil MB, Ghadge PM. Effect of planting density on growth and yield in guava. Journal of Maharashtra Agricultural Universities. 2004;29(20):226.
24. Ravishankar H, Shivananda TN, Purohit AG. Effect of planting density on growth parameters and fruit yield in guava Allahabad Safeda cultivated in mid humid conditions of Coorg. J Hort. Sci. 2008;3(2):123-126.
25. Saini RS, Ram Dayal, Rakesh. Effect of spacing on fruit drop, yield and quality of ber cv. Gola under rainfed conditions. Crop Research (Hisar). 1995;10(30):324-326.
26. Sdoodee S, Phonrong K, Ruongying Y. Mangosteen crop load affects physiological responses, fruit yield and fruit quality. Acta Horticulture. 2008;773:187-194.
27. Sheikh MK, Rao MM. Effect of pruning and fruit load on yield and quality in pomegranate (*Punnica granatum* L.) var. ganesh. Karnataka Journal of Agricultural science. 2002;15(3):549-555.
28. Sidhu PJS, Karla SK, Dhaliwal GS, Raghbir Singh, Singh SN. Effect of different spacings on vegetative growth and nutrients levels in leaves of guava (*Psidium guajava* L.) cv Allabad sufeda. Punjab Hort. J. 1992;32(1-40):55-59.
29. Singh B. Thinning of plums Indian J Agric Sci. 1961;31:64-76.
30. Singh G. High density planting and crop regulation in guava. In: Shukla RP, Kishun R, Kapoor BP. (eds). Manual of summer school on recent advances in production, protection and post-harvest of sub-tropical fruits. CISH. Lucknow; c2002, 1-7p.
31. Singh G, Singh AK, Mishra D. High density planting in Guava. Acta horticulture. 2007;735:2235-2241.
32. Singh G. High density and meadow orcharding in guava. A Technical Bulletin Published by Central Institute for Sub-tropical Horticulture, Lucknow. 2008, 1-20.
33. Singh IS, Singh HK, Chauhan KS. Effect of high and low density plantation on yield and quality of guava under semi-arid conditions. Haryana Agri. Univ. J Res. 1980;10(40):21-23.
34. Subhash Chander, Reju M Kurian. Effect of crop load, fruit position and shoot vigour on yield and quality of Annona atemoya × Annona squamosa in India. Journal of Horticultural Science and Biotechnology. 2019;94(4):507-12. 10.1080/14620316.2019.1592712.
35. Yadav ED, Gaikwad MR, Patil AV. The relation between tree growth, chlorophyll content and plant density of Sardar guava (*Psidium guava* L.). nat. symp. Trop. And Subtrop. Fruit Crops. Banglore. 1981, 30.
36. Zhu ZJ, Jiang CY, Shi YH. Response of yield and leaf photosynthesis to sink-source ratio altering demand in olive. Sci. Agri. Sinica. 2015;48:546-554.
37. Sharma ML, Gander GA, Hunt CG. Spatial variability of infiltration in a watershed. Journal of Hydrology. 1980 Jan 1;45(1-2):101-22.
38. Mohammed M, Swales J. Factors affecting the successful reading of technical instructions. 1984;2:206-217.
39. Islam MK, Merlo J, Kawachi I, Lindström M, Gerdtham UG. Social capital and health: Does egalitarianism matter? A literature review. International journal for equity in health. 2006 Dec;5(1):1-28.
40. Pawar NA, Shaikh IJ. Nitrate pollution of ground waters from shallow basaltic aquifers, Deccan Trap Hydrologic Province, India. Environmental Geology. 1995 Apr;25(3):197-204.
41. Adhikari U, Nejadhashemi AP, Woznicki SA. Climate change and eastern Africa: a review of impact on major crops. Food and Energy Security. 2015 Jul;4(2):110-32.
42. Dhaliwal U, Arora VK, Singh N, Bhatia A. Cytopathology of chalazia. Diagnostic Cytopathology. 2004 Aug;31(2):118-22.
43. Mohamed M, Mosha F, Mghamba J, Zaki SR, Shieh WJ, Paweska J, *et al*. Epidemiologic and clinical aspects of a Rift Valley fever outbreak in humans in Tanzania, 2007. The American journal of tropical medicine and hygiene. 2010 Aug 8;83(2S):22.
44. Mohammad HM, Mohammad AFF. Studies on effect of some bio fertilizer of growth of peach seedling and root disease incidence. Egypt. J Hort. 2005;26(1):7-18.
45. Casierra-Posada F, Rodríguez Puerto JI, Cárdenas Hernández J. Leaf to fruit ratio affects yield, fruit growth and fruit quality of peach (*Prunus persica* L. Batsch, cv. 'Rubidoux'). Revista Facultad Nacional de Agronomia Medellin. 2007 Jun;60(1):3657-9.