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Effect of severity of pruning and fruit retention on yield and quality of custard apple

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Abstract
The present investigation entitled "Effect of severity of pruning and fruit retention on vegetative parameters of custard apple" was carried out during 2019-20 and 2020-21 farmers field at Dhanaj (Bu), Tq- Karanja, Dist- Washim (MS). The experiment was laid out in Split Plot Design designed with four severity of pruning viz., P_{1-} No pruning (control), P_{2-} Light pruning: thickness of branch 3-5mm (Refill thickness), P_{3-} Medium pruning: thickness of branch 6-10mm (Pencil thickness) and P_{4-} Hard pruning: thickness of branch 11-15mm (Thumb thickness) and fruit thinning are T_{1-} no thinning (control), T_{2-} Fruit retention up to 100 fruits per plant, T_{3-}fruit retention up to 80 fruits per plant, T_{4-} Fruit retention up to 60 fruits per plant and T_{5-} fruit retention up to 40 fruits per plant. Maximum fruit yield per plant, fruit yield per plot and fruit yield per hectare was recorded in medium pruning and no thinning. However, maximum weight of fruit, fruit length and fruit breadth were recorded in medium pruning and fruit retention upto 40 fruits per plant followed by fruit retention upto 60 fruits per plant

Keywords: Pruning, fruit retention, yield, custard apple

Introduction
Among annonaceous fruits, Custard apple (*Annona squamosa* L.) a tropical fruit crop 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 as bio-pesticides. 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 (*Annona squamosa* L.) is generally classed as a semi-wild fruit and one of the finest fruits gifted to India by tropical America and West Indies. It is also known as sharifa, sitaphal, sugar apple, sweetsop, sitaphalam etc. Custard apple is now grown in Brazil, Australia, Myanmar, Mexico, Israel, Philippines, Spain, West Indies, India, Sri-Lanka and has commercial importance in Egypt and Central Africa (Rajput and Pattanayak, 1985) [16]. Custard apple is mostly consumed as table fruit. It can be preserved as jam, jelly and powder which are also used in ice-cream and other milk products. The edible portion of fruit is creamy, granular with an excellent blend of sweetness and acidity. The immature fruit, seeds, leaves and roots are known for their medicinal use in Ayurved (Parekh and Sharma, 1993) [13]. In Custard apple the flowering occurs singly or rarely in small clusters and observed mostly on both old and current season's growth and very rarely on older wood. The flowering period of custard apple is very long commencing from March-April, continuing up to July-August. The peak flowering is observed in April and May. (Rajput and Pattanayak, 1985) [16]. Pruning is removal of any parts of tree, especially shoots, roots, buds or nipping of terminal parts. The main objective of pruning is to remove the non-productive parts and to divert the energy into those parts that are capable of bearing fruits. Pruning has been found to influence on many crops (Patil, 1987) [14]. Summer pruning has the potential to increase yields with some cultivars of custard apple. The increase in length and diameter of subsequent new shoots produced after pruning is directly proportional to the severity of pruning. Average fruit size and weight is also increased in pruned trees as compared to those in un-pruned ones (Ghum, 2011) [8]. Fruit thinning is the removal of fruitlets in heavy fruit set situations in plant aiming to increase fruit sizes, avoid branch breakdown, reduce harvesting costs, and promote a balance costs, and promote a balance between the vegetative and reproductive growth of plant (Peres 2017) [15]. Fruit thinning is effective in managing the relationship between vegetative and reproductive growth, which ensures high quality and yield in fruit trees by adjusting the relationship between "sink" and "source" and changing the transportation and distribution of

photosynthate. Fruit thinning has been shown successfully to overcome alternate bearing, increase nutrient accumulation, and prevent premature aging (Morandi and Grappadelli, 2009, Seehuber, 2011) [12, 18].

Materials and Methods

The present research programmed is laid out in Split Plot Design consisting four severity of pruning and five fruit retention on tree replicated three times. Ten years old custard apple plant used for research programmed. Five plant was selected under each treatment. Pruning was done in in last week of May with four severity of pruning viz., P_{1}- No pruning (control), P_{2}- Light pruning: thickness of branch 3-5mm (Refill thickness), P_{3}- Medium pruning: thickness of branch 6-10mm (Pencil thickness) and P_{4}- Hard pruning: thickness of branch 11-15mm (Thumb thickness) and fruit thinning done when fruit was aonla size with fruit thinning are T_{1}- no thinning (control), T_{2}- Fruit retention up to 100 fruits per plant, T_{3-F}fruit retention up to 80 fruits per plant, T_{4}- Fruit retention up to 60 fruits per plant and T_{5}- fruit retention up to 40 fruits per plant. All cultural practices recommended for this fruit crop were timely adopted.

Result and Discussion

1) Fruit yield per plant (kg/plant)

The data from Table 1. showed that, significantly maximum fruit yield per plant (23.51 and 27.38 kg) was recorded in medium pruning followed by light pruning (21.49 and 26.84 kg) during first and second year, respectively. However, minimum fruit yield per plant (17.44 and 20.57 kg) was recorded in unpruned tree during first and second year, respectively. On pooled basis, the significantly highest fruit yield per plant (25.44 kg) was found in medium pruning and followed by light pruning (24.16 kg). The lowest fruit yield per plant (19.00 kg) was found in unpruned plant. This might be due to pruning forces tree into investing more of its energy into manufacture of fructose instead of cellulose. Pruning increases ability to take water, carbon dioxide and sunlight to make carbohydrates or sugars which ultimately encourage the tree to produce more fruits. These findings are in accordance with the results obtained by Shaikh and Rao (2002) [19] in pomegranate, Ghum (2011) [8] in custard apple and Sharma (2014) [20] in apple. The data regarding to fruit retention, significantly maximum fruit yield per plant (23.25 and 25.80 kg) was found in no thinning which were found at par with fruit retention up to 100 fruits per plant (22.40 and 24.18 kg) and followed by fruit retention up to 80 fruits per plant (19.69 and and 23.88 kg) during first and second year, respectively. However, minimum fruit yield per plant (15.53 and 17.03 kg) was recorded in fruit retention up to 40 fruits per plant during first and second year, respectively. On pooled basis, the significantly highest fruit yield per plant (24.52 kg) was found in no thinning treatment which were found at par with fruit retention up to 100 fruits per plant (23.29 kg) followed by fruit retention up to 80 fruits per plant (21.78 kg). However, lowest fruit yield per plant (16.28 kg) was recorded in fruit retention up to 40 fruits per plant. Reduction in yield with this treatment could be attributed to decrease in number of fruits per tree. Similar findings were also reported by Chanana *et al*. (1998) [5] and Casierra *et al*. (2007) [3] in peach. Sdoodee *et al*. (2008) [17] reported that the highest yield was found in high crop load in mangosteen trees.

2) Fruit yield per plot (kg)

The data from Table 1. showed that, significantly maximum fruit yield per plot (117.55 and 136.90 kg) was recorded in medium pruning and followed by light pruning (107.45 and 130.40 kg) during first and second year, respectively. However, minimum fruit yield per plot (87.20 and 101.90 kg) was recorded in unpruned plant during first and second year, respectively. On pooled basis, the significantly highest fruit yield per plot (127.32 kg) was found in medium pruning followed by light pruning (118.92 kg). The lowest fruit yield per plot (94.55 kg) was found in unpruned plant. This might be due to pruning forces tree into investing more of its energy into manufacture of fructose instead of cellulose. Pruning increases ability to take water, carbon dioxide and sunlight to make carbohydrates or sugars which ultimately encourage the tree to produce more fruits. These findings are in accordance with the results obtained by Shaikh and Rao (2002) [19] in pomegranate, Ghum (2011) [8] in custard apple and Sharma (2014) [20] in apple. The data regarding to fruit retention, significantly maximum fruit yield per plot (116.25 and 129.00 kg) was found in no thinning which were found at par with fruit retention up to 100 fruits per plant (112.00 and 125.90 kg) and fallowed by fruit retention up to 80 fruits per plant (98.45 and 119.40 kg) during first and second year, respectively. However, minimum fruit yield per plot (77.65 and 85.15 kg) was recorded in fruit retention up to 40 fruits per plant during first and second year, respectively. On pooled basis, the significantly highest fruit yield per plot (122.62 kg) was found in no thinning treatment which were found at par with fruit retention up to 100 fruits per plant (118.95 kg) and followed by fruit retention up to 80 fruits per plant (108.92 kg). However, significantly, lowest fruit yield per plot (81.04 kg) was recorded in fruit retention up to 40 fruits per plant. Reduction in yield with this treatment could be attributed to decrease in number of fruits per tree. Similar findings were also reported by Chanana *et al*. (1998) [5] and Casierra *et al*. (2007) [3] in peach. Sdoodee *et al*. (2008) [17] reported that the highest yield was found in high crop load in mangosteen trees.

3) Fruit yield per hectare (t ha^{-1})

The data from Table 1. showed that, significantly maximum fruit yield per hectare (26.12 and 30.42 t ha^{-1}) was recorded in medium pruning followed by light pruning (23.87 and 28.97 t ha^{-1}) during first and second year, respectively. However, minimum fruit yield per hectare (19.37 and 22.64 t ha^{-1}) was recorded in unpruned tree during first and second year, respectively. On pooled basis, the significantly highest fruit yield per hectare (28.27 t ha^{-1}) was found in medium pruning and followed by light pruning (26.42 t ha^{-1}). The lowest fruit yield per hectare (21.00 t ha^{-1}) was found in unpruned plant. The yield per hectare was maximum because of optimum balance between the vegetative and reproductive growth of trees, and maximum number of fruits increases the yield per hectare. In guava the flowers and fruits are born on current season growth, a light annual pruning is necessary to encourage new shoots after harvest. Pruning also reduces tree crown area and increase number of fruits. The results are in close agreement with the finding and Ghum (2011) [8] in custard apple, Kumar and Rattanpal (2010) [9] in guava, Masalkar and Joshi (2009) [10] and Shaikh and Rao (2002) [19] in pomegranate. The data regarding to fruit retention, significantly maximum fruit yield per hectare (25.83 and

28.66 t ha^{-1}) was found in no thinning which were found at par with fruit retention up to 100 fruits per plant (24.89 and 27.97 t ha^{-1}) and fallowed by fruit retention up to 80 fruits per plant (21.87 and 26.53 t ha^{-1}) during first and second year, respectively. However, minimum fruit yield per hectare (17.25 and 18.92 t ha^{-1}) was recorded in fruit retention up to 40 fruits per plant first and second year, respectively. On pooled basis, the significantly highest fruit yield per hectare (27.24 t ha^{-1}) was found in no thinning which were found at par with fruit retention up to 100 fruits per plant (26.40 t ha^{-1}) and followed by fruit retention up to 80 fruits per plant (24.20 t ha^{-1}). However, lowest fruit yield per hectare (18.08 t ha^{-1}) was recorded in fruit retention up to 40 fruits per plant. Reduction in yield with this treatment could be attributed to decrease in number of fruits per tree. Similar findings were also reported by Chanana *et al*. (1998) [5] and Casierra *et al*. (2007) [3] in peach. Sdoodee *et al*. (2008) [17] reported that the highest yield was found in high crop load in mangosteen trees.

4) Weight of fruit (g)

The data from Table 2. showed that, significantly maximum fruit weight (313.35 and 314.58 g) was found in medium pruning and followed by light pruning (292.64 and 293.91 g) during first and second year, respectively. However, minimum fruit weight (237.76 and 238.90 g) was recorded in unpruned plant during first and second year, respectively. On pooled basis, the significantly maximum fruit weight (313.97 g) was found in medium pruning followed by light pruning (293.30 g). The minimum fruit weight (238.29 g) was found in unpruned plant. This is might be due to the intensity of pruning and fruits produced by subjected to medium pruning had higher average weight in relation to fruits produced by plants subjected to light pruning. The results of present findings are in agreement with the findings of Choudhary *et.al* (2020) [6] and Mohamed *et al*. (2010) [11] in custard apple The data regarding to fruit retention, significantly maximum fruit weight (373.53 and 374.76 g) was found in fruit retention up to 40 fruits per plant and followed by fruit retention up to 60 fruits per plant (337.40 and 338.63 g). However, minimum fruit weight (146.95 and 148.18 g) was recorded in no thinning. On pooled basis, the significantly highest fruit weight (374.14 g) was found in fruit retention up to 40 fruits per plant and followed by fruit retention up to 60 fruits per plant (338.01 g). However, lowest fruit weight (147.56 g) was recorded in no thinning. It might be due to the reduction in the number of fruits per tree thereby increasing the leaf to fruit ratio which resulted in increased availability of photosynthates and lesser nutritional competition among the developing fruits, thus improving the fruit weight. These results are supported by the findings of Chahill *et al*. (1980) [4] and Casierra *et al.* (2007) [3] in peach.

5) fruit length (cm)

The data from Table 2. showed that, significantly maximum fruit length (10.04 and 10.97 cm) were recorded in medium pruning and followed by light pruning (9.15 and 9.95 cm) during first and second year, respectively. However, minimum fruit length (6.05 and 7.57) were recorded in unpruned plant during first and second year, respectively. On pooled basis, the significantly highest fruit length (10.50 cm) was found in medium pruning and followed by light pruning (9.55 cm). The lowest fruit length (6.81 cm) was found in unpruned plant. This might be due to more nutrient supply to a limited number of fruits in case of hard pruning. Reducing fruit numbers at or soon after flowering has the effect of reducing competition for resources between fruit allowing individual fruit to develop greater cell numbers. The result of present finding is in line with Choudhary *et.al* (2020) [6] and Mohamed *et al.* (2010) [11] in custard apple. The data regarding to fruit retention, significantly maximum fruit length (11.05 and 12.13 cm) was found in fruit retention up to 40 fruits per plant and followed by fruit retention up to 60 fruits per plant (9.56 and 10.66 cm) during first and second year, respectively. However, minimum fruit length (6.50 and 7.71 cm) was recorded in no thinning during first and second year, respectively. On pooled basis, the highest fruit length (11.59 cm) was found in fruit retention up to 40 fruits per plant followed by fruit retention up to 60 fruits per plant (10.11 cm). However, lowest fruit length (7.10 cm) was recorded in unthinned plant. Increase in the size could be attributed to increase in leaf to fruit ratio as a result of thinning, thus increasing the availability of photosynthates and nutrients to the remaining fruits thereby increasing the length of individual fruits. This result is in accordance with the finding of Davarynejad *et al*. (2008) [7] in sour cherry and Singh and Bajwa (1965) [21] in plum.

6) Fruit breadth (cm)

The data from Table 2. showed that, significantly maximum fruit breadth (9.49 and 10.36 cm) was recorded in medium pruning followed by light pruning (8.70 and 9.71 cm) during first and second year, respectively. However, minimum fruit breadth (6.10 and 7.10 cm) was recorded in unpruned plant during first and second year, respectively. On pooled basis, the significantly highest fruit breadth (9.92 cm) was found in medium pruning followed by light pruning (9.20 cm). The lowest fruit breadth (6.60 cm) was found in unpruned plant. This may be due to more nutrient supply to a smaller number of fruits in case of severe pruning. Reducing fruit numbers at or soon after flowering has the effect of reducing competition for resources between fruit allowing individual fruit to develop greater cell numbers. The result of present finding is in line with Choudhary *et al* (2020) [6] in custard apple, and Bhagawati Rupankar *et al*. (2015) [2] in guava. The data regarding to fruit retention, significantly maximum fruit breadth (10.67 and 11.99 cm) was found in fruit retention up to 40 fruits per plant followed by fruit retention up to 60 fruits per plant (9.85 and 10.18 cm) during first and second year, respectively. However, minimum fruit breadth (6.57 and 7.51 cm) was recorded in no thinning during first and second year, respectively. On pooled basis, the significantly highest fruit breadth (11.16 cm) was found in fruit retention up to 40 fruits per plant and followed by fruit retention up to 60 fruits per plant (10.05 cm). However, lowest fruit breadth (7.04 cm) was recorded in unthinned plant. The increase in fruit breadth might be due to the reduction in the number of fruits per tree thereby increasing the size of the cell and cell elongation which resulted in maximum accumulation of the food materials in the developing fruits, thus improving the fruit size. These results are in close agreement with the findings of Arora *et.al* (2001) [1] and Casierra *et al*. (2007) [3] in peach.

Table 1: Effect of severity of pruning and fruit retention on fruit yield, fruit yield per plot and fruit yield per hectare of custard apple.

Treatments	Fruit yield per plant (kg/plant)			Fruit yield per plot (kg)			Fruit yield per plant (t ha^{-1})		
	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean
A- Pruning (P)									
P_1 – Control	17.44	20.57	19.00	87.20	101.90	94.55	19.37	22.64	21.00
P_2 - Light pruning	21.49	26.84	24.16	107.45	130.40	118.92	23.87	28.97	26.42
P_3- Medium pruning	23.51	27.38	25.44	117.55	136.90	127.32	26.12	30.42	28.27
P_4- Hard pruning	19.03	23.92	21.47	97.10	119.60	108.35	21.57	26.57	21.07
F test	Sig.	Sig	Sig	Sig.	Sig	Sig	Sig.	Sig	Sig
SE (m)	0.45	0.50	0.47	1.84	1.70	1.77	0.67	0.43	0.55
CD at 5%	1.35	1.49	1.42	5.52	5.11	5.31	2.02	1.30	1.66
B. Fruit retention (T)									
T_1-No thinning	23.25	25.80	24.52	116.25	129.00	122.62	25.83	28.66	27.24
T_2- 100 fruit retention	22.40	24.18	23.29	112.00	125.90	118.95	24.89	27.97	26.40
T_3- 80 fruit retention	19.69	23.88	21.78	98.45	119.40	108.92	21.87	26.53	24.20
T_4- 60 fruit retention	16.74	21.09	18.91	83.70	105.45	94.75	18.60	23.43	21.01
T_5- 40 fruit retention	15.53	17.03	16.28	77.65	85.15	81.04	17.25	18.92	18.08
F test	Sig.	Sig	Sig	Sig.	Sig	Sig	Sig.	Sig	Sig
SE (m)	0.59	0.55	0.57	2.04	1.95	1.99	0.63	0.53	0.58
CD at 5%	1.80	1.65	1.72	6.12	5.85	5.98	1.90	1.60	1.75
C. Interaction									
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE (m)	1.19	1.11	1.15	4.07	3.89	3.98	1.25	1.05	1.15
CD at 5%	-	-	-	-	-	-	-	-	-

Table 2: Effect of severity of pruning and fruit retention on weight of fruit, fruit length and fruit breadth of custard apple.

Treatments	Weight of fruit (g)			Fruit length (cm)			Fruit breadth (cm)		
	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean	2019-20	2020-21	Pooled mean
A- Pruning (P)									
P_1 – Control	237.76	238.90	238.29	6.05	757	6.81	6.10	7.10	6.60
P_2 - Light pruning	292.64	293.91	293.30	9.15	9.95	9.55	8.70	9.71	9.20
P_3- Medium pruning	313.35	314.58	313.97	10.04	10.97	10.50	9.49	10.36	9.92
P_4- Hard pruning	270.30	271.53	270.92	7.56	8.95	8.25	7.52	8.23	7.57
F test	Sig.	Sig	Sig	Sig.	Sig	Sig	Sig.	Sig	Sig
SE (m)	3.46	2.82	3.14	0.23	0.22	0.22	0.25	0.28	0.27
CD at 5%	10.02	8.12	9.07	0.70	0.65	0.65	0.75	0.54	0.64
B. Fruit retention (T)									
T_1-No thinning	146.95	148.18	147.56	6.50	7.71	7.10	6.57	7.51	7.04
T_2- 100 fruit retention	247.35	248.58	247.96	6.90	8.95	7.92	7.65	9.52	8.59
T_3- 80 fruit retention	287.29	288.52	287.90	8.96	9.98	9.47	8.68	10.57	9.63
T_4- 60 fruit retention	337.40	338.63	338.01	9.56	10.66	10.11	9.85	10.18	10.05
T_5- 40 fruit retention	373.53	374.76	374.14	11.05	12.13	11.59	10.67	11.99	11.16
F test	Sig.	Sig	Sig	Sig.	Sig	Sig	Sig.	Sig	Sig
SE (m)	5.56	6.12	5.84	0.33	0.30	0.32	0.28	0.27	0.27
CD at 5%	16.00	17.62	16.81	1.0	0.89	0.94	0.84	0.81	0.42
C. Interaction									
F test	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE (m)	11.11	12.34	11.72	0.89	0.59	0.65	0.55	0.55	0.55
CD at 5%	-	-	-	-	-	-	-	-	-

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