DOI: 10.15740/HAS/AU/12.TECHSEAR(3)2017/804-811 *Agriculture Update*
Volume **12** | TECHSEAR-3 | 2017 | 804-811
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RESEARCH ARTICLE :

Studies on crop load, fruit thinning and their effects on growth attributes of guava (*Psidium guajava* L.) cv. ALLAHABAD SAFEDA under meadow planting system

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ARTICLE CHRONICLE :
Received :
13.07.2017;
Accepted :
28.07.2017

SUMMARY : The study was carried out at the Fruit research station, Sangareddy, Telangana, Sri Konda Laxman Telangana State Horticulture University, Hyderabad during the period of October, 2016 to February, 2017 (Hasta bahar crop) to find out the effect of fruit thinning on growth attributes of guava (*Psidium guajava* L.) cv. ALLAHABAD SAFEDA under meadow planting system. The treatments of the experiment were crop load levels *i.e.* retaining of 5, 10, 15, 20 fruits per plant and control (No thinning) and second factor as a observations recorded after fruit thinning *i.e.* (i) 30 days after fruit set (ii) 60 days after fruit set (iii) 90 days after fruit set and at the time of harvest. The ages of the plants were 4-5 years. Results revealed that the significant differences were noticed in guava cv. ALLAHABAD SAFEDA for different vegetative and fruit growth parameters studied in hasta bahar crop. There is an increasing trend during growth and development in shoot length, leaf area index, and fruit growth parameters like fruit length, fruit diameter and average fruit weight. At the time of harvest recorded maximum shoot length (47.88 cm), leaf area index (1.09), fruit length (6.34 cm), fruit diameter (6.92cm) and average fruit weight (175.40 g). The interaction between days after fruit set and fruit load has shown significant results that, at the time of harvest with15 fruits per plant recorded best result in shoot length (52.06 cm) and in fruit growth parameters, maximum fruit length (7.34 cm), fruit diameter (4.46 cm) and fruit weight (236.46 g) was recorded in 5 fruits per plant at the time of harvest.

KEY WORDS :
Shoot length, Leaf area index, Thinning, Crop load

How to cite this article : Patil, Prabhugouda, Kumar, A. Kiran, Bhagwan, A. and Sreedhar, M. (2017). Studies on crop load, fruit thinning and their effects on growth attributes of guava (*Psidium guajava* L.) cv. ALLAHABAD SAFEDA under meadow planting system. *Agric. Update,* **12**(TECHSEAR-3) : 804-811; **DOI: 10.15740/HAS/AU/12.TECHSEAR(3)2017/804-811.**

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BACKGROUND AND OBJECTIVES

Guava is an important fruit crop in tropical and subtropical regions of the country due to the hardy nature of its plant and prolific bearing even in marginal lands (Singh, 1995). Its cultivation requires little care and inputs. But, of late, this crop has exhibited a paradigm shift in the production system, from subsistence farming to commercial production. The traditional system of cultivation has often posed problems in attaining desired levels of

productivity due to large plant canopy. Hence, a need arose to improve the existing production system, besides increasing its productivity. Currently, there is a worldwide trend to plant fruit plants at higher density or meadow orcharding to control plant size and maintain desired architecture for better light interception and ease in operations such as pruning, pest control and harvesting. The high density or meadow orcharding facilitates enhance production and quality of fruits.The yield and quality of fruit is poor as it has not received the deserved attention in its cultivation. A package of practice is imperative to enhance the growth and quality of guava fruits by crop load and fruit thinning. Crop load is a significant factor for maximizing both fruit colour and fruit size. Excessive crop loading reduces fruit coloration through direct shading of neighbouring fruit, or through competition for assimilates needed for coloration. A high fruit to leaf ratio may mean that the leaves cannot produce enough carbohydrates to colour or size all of the fruit to their full potential (Tahir and Kamran, 2002). Fruit thinning is therefore needed to ensure the fruit to leaf ratio is within the desired range to reach an adequate size, and good quality fruits.

Guava fruits are popular due to its nourishing value and good taste. It is known as 'Apple of Tropics' and rich source of vitamin-C and pectin content besides being a good source of other vitamins and minerals (Patel *et al*., 2013). The yield and quality of fruit is poor as it has not received the deserved attention in its cultivation. A package of practice is imperative to enhance the growth and quality of guava fruits by crop load and fruit thinning. Crop load is a significant factor for maximizing both fruit colour and fruit size. Excessive crop loading reduces fruit coloration through direct shading of neighbouring fruit, or through competition for assimilates needed for coloration. A high fruit to leaf ratio may mean that the leaves cannot produce enough carbohydrates to colour or size all of the fruit to their full potential(Tahir and Kamran, 2002). Fruit thinning is therefore needed to ensure the fruit to leaf ratio is within the desired range to reach an adequate size, and good quality fruits.The yield and quality of fruit is poor as it has not received the deserved attention in its cultivation. A package of practice is imperative to enhance the growth and quality of guava fruits by crop load and fruit thinning.

RESOURCES AND METHODS

The experiment was carried out during the period of October, 2016 to February, 2017 (Hasta bahar crop) at Fruit Research Station (FRS), Sangareddy, SKLTSHU, Telangana.Fruit Research Station was situated at an altitude of 1743 feet above mean sea level on 17° 37.300' North latitude and 78° 04.601'18 East longitude.The experiment was laid out in Randomized Block Design with factorial concept with 20 treatments in 3 replications. The fruits were tagged in four directions of plant during the thinning time as per the treatments and replicated three times;plants are of 4-5 years old and planted in 2×1m spacing. The data was recorded at monthly intervals from fruit set to harvest to observe the fruit development pattern with thinning effects. The treatments of the experiment were crop load levels *i.e.* retaining of 5, 10, 15, 20 fruits per plant and control (No thinning) and second factor as a observations recorded after fruit thinning *i.e.* (i) 30 days after fruit set (ii) 60 days after fruit set (iii) 90 days after fruit set and at the time of harvest. The observations recorded are as follows shoot length, leaf area index (LAI), fruit length, fruit diameter and average fruit weight.

Physical parameters:

Shoot length (cm):

The shoot length was measured after fruit set according to treatments of 30 days after fruit set, 60 days after fruit set, 90 days after fruit set, and at the time of harvest with different crop load.

Leaf area index:

LAI was first defined in 1947 as the total one-sided area of photosynthetic tissue per unit ground surface area. After reviewing various other definitions (some measurement approach – dependent), Jonckheere *et al.* (2004) concluded that in current literature, LAI is defined as one half of the total leaf area per unit ground surface area. They also noted that different definitions can result in significant differences between calculated LAI values. LAI is a dimensionless quantity (or m^2/m^2). Breda (2003) reviewed an approach of light transmittance measurement through a canopy to obtain information on daily of LAI changes within a stand.

Leaf area index in Guava was calculated with using an instrument called digital plant canopy imager (CID Bio Science, Inc). Leaf area index is the ratio of foliage

area to ground area. Canopy imager is having optical sensor consists of fisheye lens and an optical system. The fish eye lens sees a hemispherical image, which the optical system focuses onto the photodiode optical sensor, which is made up of five concentric rings. Leaf area index was taken every 30 days interval upto harvest.

Fruit length, diameter and average fruit weight:

Fruit length and diameter were measured at 30, 60, 90 days after fruit set and at the time of harvest from randomly selected fruits during study. The length from base of fruit to the base of the calyx and diameter at the maximum bulge of fruit from both side were measured with help of 'digital vernier caliper' and mean values of length and diameter were presented in cm. The weight of the fruits was calculated on the basis of 2-3 representative fruits and the mean was expressed in gram.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Shoot length (cm):

The shoot length varied significantly after fruit thinning at 30, 60, 90 days after fruit set and at the time of harvest in guava cv. ALLAHABAD SAFEDA during vegetative growth presented in Table 1. The length of shoots increased from 30 days after fruit set (38.45 cm) followed by 60 days after fruit set (41.83cm), 90 days after fruit set (45.35cm) and at the time of harvest the shoot length was (47.88 cm). Guak *et al*. (2003) growth is generally considered to includelinear increase, increase in dimension, gain in organic mass and cell multiplication. In general, pruning intensities influenced the plant growth, which might be due to removal of apical dominance of a bud. Growth response as expressed in shoot growth. Pruning has its physiological effects basically due to changes in the partitioning of the reserves. It changes sink preference for allocation of photosynthates. Depending upon the time of the year, the extent and frequency of pruning, some sites of accumulation will disappear and others will be created. As a result, changes in seasonal fluctuations of reserves can appear as well and effect on shoot length in fruit crops (Clair *et al*., 1999). The shoot length differed significantly due to crop load treatments and the highest shoot length was noticed in 15 fruits per plant (46.01) and lowest was observed in 5 fruits per plant (42.33 cm) which was on par with 10 fruits per plant (42.67 cm), 20 fruits per plant (42.82 cm) and control (42.82 cm). While a high fruit load decreases the distribution of assimilates to the roots and other permanent plant organs, the lack of assimilates may also have negative effects on growth and fruit production (Lenz, 2009).The increase in shoot length might be attributed to the fact that there was less number of shoots and more food reserves available to individual shoots, which were left after pruning (Wunsche and Pahner, 1997).The interaction of days after fruit set and crop load shown non-significant difference in shoot length.

Leaf area index:

Leaf area index was significantlyaffected after fruit thinningat 30, 60, 90 days after fruit set and at harvest presented in Fig. 1. Among the treatments, at the time of

Table 1: Effect of crop load on shoot length (cm) after thinning (30, 60, 90 days and at the time of harvest) in guava cv. ALLAHABAD SAFEDA under meadow planting system

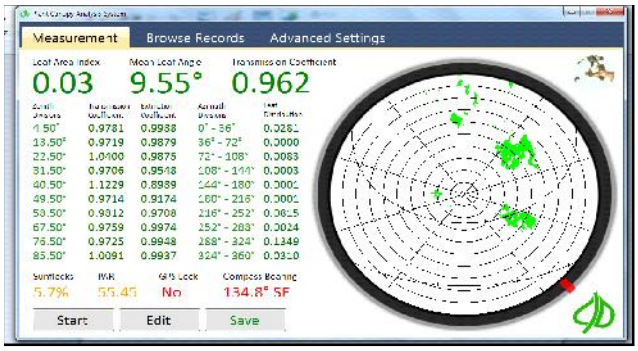
Treatments	Days after fruit set(DAS)				
Crop load (CL)	30	60	90	At harvest	Mean
5 fruits per plant	38.30	41.22	43.94	45.86	42.33[a]
10 fruits per plant	36.67	41.98	44.85	47.20	42.67[a]
15 fruits per plant	41.69	42.04	48.26	52.06	46.01[b]
20 fruits per plant	38.47	41.85	44.67	47.25	43.06[a]
Control	37.13	42.05	45.03	47.06	42.82[c]
Mean	38.45[A]	41.83[B]	45.35[C]	47.88[D]	
	DAS (A)	CL (B)		A × B	
C.D. (P=0.05)	2.17	2.43		NS	
S.E. ±	0.76	0.85		1.69	

NS=Non-significant

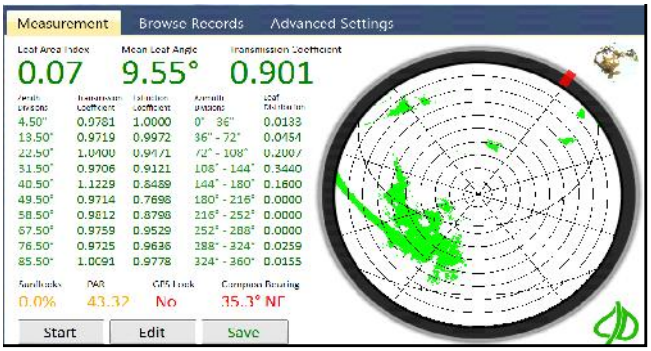
harvest recorded significantly maximum leaf area index (1.09) followed by 90 days after fruit set (0.23) and minimum leaf area index is noticed in 30 days after fruit set (0.04) showed in Table 2. Leaf area index is an indicator for better plant growth. Leaf area index is directly related to the canopy interception. Therefore with increasing the leaf area index the canopy interception of guava also increased (Lakso and Flore, 2003).Similar results obtained from Patode *et al*. (2015) reported that leaf area index for custard apple and atemoya goes on increasing with increase in the growth of the plant. Maximum leaf area index was in the month of October in custard apple (0.70) and in the month of September (1.91) in atemoya. Leaf area index decreased once the leaves mature and shred. Minimum quantities of leaf area and shoot structure are required for setting large fruit crops (Lakso and Flore, 2003). The data on the leaf area indexwas not significantly affected by crop load. According to Lechaudel *et al*. (2005) a high number of fruit buds per plant is desirable to achieve higher yield per unit area, the competition for assimilates among fruits can reduce whole canopy leaf area, which leads to a lower fruit quality. The interaction between days after fruit set and crop load was found to be non-significant on leaf area index.

Fruit length (cm):

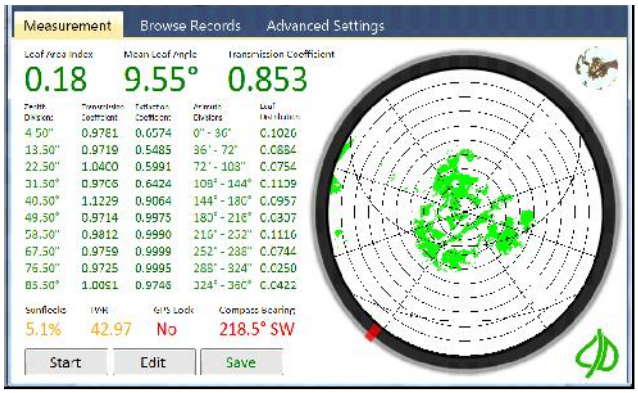
The fruit length varied significantly after thinning at 30, 60, 90 days after fruit set and at the time of harvest of guava during study. Gradual increase in fruit length was observed during fruit growth from fruit set to time of harvest.The fruit length varied significantly during study. The average fruit length at 30 days after fruit set (2.21 cm) followed by 60 days after fruit set (2.96 cm), 90 days after fruit set (4.58 cm) and significantly maximum fruit length was noticed at the time of harvest (6.34 cm).These results are evident from Singh and Jain (2007) the fruit growth of Allahabad Safeda in terms of length and width was maximal during 30-60 days. Man Bihari and Suryanarayan (2011) also observed the



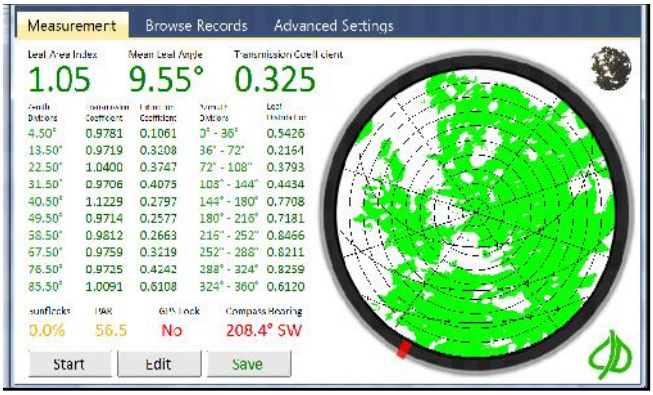
30 days after fruit set



60 days after fruit set



90 days after fruit set



At the time harvest

Fig. 1 : Leaf Area Index data after thinning at 30 days after fruit set, 60 days after fruit set, 90 days after fruit set and at the time of harvest

variation among fourteen genotypes studied in respect to fruit length in guava. Patel *et al*. (2015) noted that a gradual increase in fruit length was observed in different genotypes of guava throughout development and ripening stage of the fruits.The data regarding the fruit length of guava cv. ALLAHABAD SAFEDA significantly varied among the treatments (5, 10, 15, 20 fruits per plant and control (no thinning)). The maximum fruit length was marked in 5 fruits per plant (4.65 cm) followed by 10 fruits per plant and minimum fruit length was noticed in control (3.43 cm).The increase in fruit length and breadth might be due to the reduction in the number of fruits per plant 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 collaboration with the findings of Arora and Chanana (2001) and Casierra *et al*. (2007). The interaction of days after fruit set and crop load shown significant variation. The highest fruit length was observed in combination of 5 fruits per plant (7.34 cm) followed by 10 fruits per plant (6.50 cm) at the time of harvest and minimum fruit length was noticed in control (5.29 cm) at the time of harvest.The interaction of days after fruit set and crop load shown significant variation (Table 3). The highest fruit length was observed in combination of 5 fruits per plant (7.34 cm) and followed by 10 fruits per plant (6.50 cm) and minimum fruit length

Table 2 : Effect of crop load on leaf area index after thinning (30, 60, 90 days and at the time of harvest) in guava cv. ALLAHABAD SAFEDA under meadow planting system

Treatments	Days after fruit set				
Crop load	30	60	90	At harvest	Mean
5 fruits per plant	0.03	0.08	0.18	0.91	0.30
10 fruits per plant	0.05	0.07	0.18	1.11	0.35
15 fruits per plant	0.05	0.07	0.21	1.16	0.37
20 fruits per plant	0.04	0.08	0.30	1.22	0.41
Control	0.03	0.06	0.30	1.08	0.37
Mean	0.04^{A}	0.07^{B}	0.23^{C}	1.09^{D}	
	DAS(A)	CL (B)		A × B	
C.D. (P=0.05)	0.11	NS		NS	
S.E. ±	0.04	0.05		0.09	

NS=Non-significant

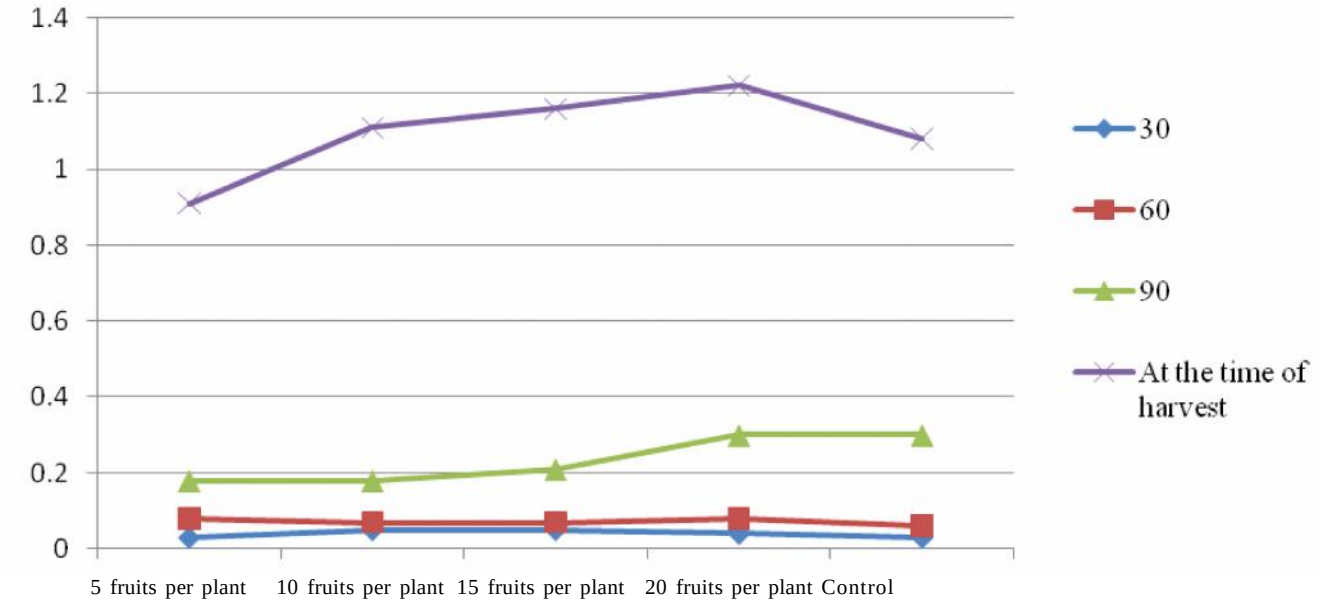


Fig. 2 : Graphical representation of leaf area index after thinning at 30 days after fruit set, 60 days after fruit set, 90 days after fruit set and at the time of harvest

was noticed in control (5.29 cm) at the time of harvest.

Fruit diameter (cm):

The fruit diameter of guava recorded a cumulative development from initial stage of fruit growth till maturity and at the time of harvest. The average diameter of fruits was (1.63 cm) on 30 days after fruit set followed by 60 days after fruit set (2.62 cm), 90 days after fruit set (4.50 cm) and significantly maximum fruit diameter (6.92 cm) was noticed at the time of harvest.The increase in fruit diameter was comparatively more between 30 to 60 days after fruit set and 90 days to at the time of harvest than 60 to 90 days after fruit set where the accumulative was slow. The major increasing fruit growth could be attributed to the increasing cell size whereas slow growth in between 60 to 90 days after fruit set was perhaps due to faster development of seed during this period that attributed to slow growth of the pulp (Dhillon *et al*., 1987 and Mercado Silva *et al*., 1998) in guava. The collective data revealed that significant variation was noticed in fruit load (5, 10, 15, 20 fruits per plant and control). However, the highest fruit diameter was noted with 5 fruits per plant (4.46 cm) followed by 10 fruits per plant which is on par with 15 fruits per plant as compared to control (3.48 cm). Due to reduction in crop load reduces initial competition for carbohydrates; thereby improving the distribution of assimilates between fruit, producing fruit with greater mass and diameter (Byers, 2003).The interaction of days after fruit set and crop load shown significant variation (Table 4). At the time of harvest recorded maximum fruit diameter in 5 fruits per plant (7.37cm) which is followed by 10 fruits per plant (4.97 cm) at 90 days after fruit set and minimum is at initial stage of fruit growth *i.e.* 30 days after fruit set with 10 fruits per plant (1.43cm).

Fruit weight:

A significant variation in fruit weight of guava cv. ALLAHABAD SAFEDA was observed at various stages of fruit development (30, 60, 90 days after fruit set and

Table 3 : Effect of crop load on fruit length (cm) after thinning at (30, 60, 90 days and at the time of harvest) in guava cv. ALLAHABAD SAFEDA under meadow planting system

Treatments	Days after fruit set(DAS)				
Crop load (CL)	30	60	90	At harvest	Mean
5 fruits per plant	2.62	3.68	4.96	7.34	4.65^{e}
10 fruits per plant	2.40	3.31	4.70	6.50	4.23^{d}
15 fruits per plant	2.18	2.83	4.62	6.40	4.00^{c}
20 fruits per plant	2.01	2.63	4.40	6.20	3.81^{b}
Control	1.87	2.36	4.21	5.29	3.43^{a}
Mean	2.21^{A}	2.96^{B}	4.58^{C}	6.34^{D}	
	DAS(A)	CL (B)		A × B	
C.D. (P=0.05)	0.14	0.16		0.31	
S.E. ±	0.05	0.06		0.11	

Table 4: Effect of crop load on fruit diameter (cm) after thinning at (30, 60, 90 days and at the time of harvest) in guava cv. ALLAHABAD SAFEDA under meadow planting system

Treatments	Days after fruit set (DAS)				
Crop load (CL)	30	60	90	At harvest	Mean
5 fruits per plant	1.74	3.78	4.97	7.37	4.46^{d}
10 fruits per plant	1.43	3.05	4.89	7.15	4.13^{c}
15 fruits per plant	1.68	3.07	4.70	7.04	4.12^{c}
20 fruits per plant	1.59	2.45	4.42	6.58	3.76^{b}
Control	1.69	2.27	3.53	6.44	3.48^{a}
Mean	1.63^{A}	2.92^{B}	4.50^{C}	6.92^{D}	
	DAS(A)	CL (B)		A × B	
C.D. (P=0.05)	0.17	0.19		0.37	
S.E. ±	0.06	0.07		0.13	

at the time of harvest). The data presented in (Table 5) showed an increasing trend in fruit weight from initial stage of fruit growth till upto harvest. The weight of the fruits was increased from 30 days after fruit set (3.68 g) followed by 60 days after fruit set (20.43 g), 90 days after fruit set (62.09 g) and reached the maximum of (175.40 g) on at the time of harvest.Similar finding was also reported by Dhillon *et al*. (1987) they found that fruit weight in Allahabad Safeda and Sardar increased upto 130 and 120 days, respectively, in the rainy season and upto 140 and 130 days, respectively in the winter season. The slow growth during 60 to 90 DAFS might be due to rapid development of seed resulting in slow growth of the pulp. The increase in fruit weight could be attributed to an increase in the size of the cells and accumulation of food substances in the intercellular spaces in fruit (Bollard, 1970).The data regarding the fruit weight of guava cv. ALLAHABAD SAFEDA significantly affected by crop load. The (Table 5) indicates that the maximum fruit weight was noticed in 5 fruits per plant (86.25 g) followed by 10 fruits per plant (73.42 g) and minimum fruit weight was noticed in control (40.07 g).Because of number of fruits per plant there by increasing the availability of photosynthates and lesser nutritional competition among the developing fruits, thus improving the fruit weight (Javaid *et al*., 2016) these results get support from Casierra *et al*. (2007). As crop load increased fruit weight showed decreasing trend. More nutrients were available to the fruits as competition among fruits was less. This may have induced an increase in cell division. These factors lead to an increase in fruit size and weight. These results are in agreement with the findings of Embree *et al*. (2007).The interaction of days after fruit set and crop load shown significant variation in fruit weight (Table 5). There is significant difference among the cropload at the time of harvest with 5 fruits per plant having highest weight of fruits (236.46 g) which is followed 90 days after fruit set (73.53 gm) and there is lowest at 30 days after fruit set with 20 fruits per plant (3.43 g).

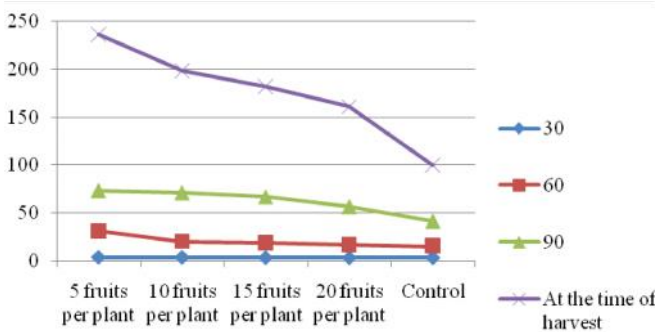


Fig. 3 : Graphical representation of fruit weight (g) at 30 days after fruit set, 60 days after fruit set, 90 days after fruit set and at the time of harvest

Conclusion:

In meadow orchard fruit yield per unit area will be more but fruit load per plant will be limited. The main season crop in Telangana state is mrig bahar crop and pruning is done in the month of May-June, fruits are harvested in Nov-Dec. To study the performance of guava in hasta bahar crop this experiment was conducted.Hence there is a scope for distribution of crop load in two seasons instead of one season will reduce stress on the plants and income of farmers can also be increased due to availability of fruits in mrig bahar and hasta bahar.From the results, it can be concluded that thinning of fruits (*i.e*. retaining of 5, 10, 15 and 20 fruits per plant) significantly improved the fruit growth

Table 5 : Effect of crop load on fruit weight (g) after thinning at (30, 60, 90 days and at the time of harvest) in guava cv. ALLAHABAD SAFEDA under meadow planting system

Treatments	Days after fruit set(DAS)				
Crop load (CL)	30	60	90	At harvest	Mean
5 fruits per plant	3.99	31.04	73.53	236.46	86.25^{e}
10 fruits per plant	3.93	20.25	71.19	198.31	73.42^{d}
15 fruits per plant	3.54	18.77	66.98	181.63	67.73^{c}
20 fruits per plant	3.43	16.81	56.94	161.01	59.54^{b}
Control	3.50	15.30	41.85	99.62	40.07^{a}
Mean	3.68^{A}	20.43^{B}	62.09^{C}	175.40^{D}	
	DAS(A)	CL (B)		A × B	
C.D. (P=0.05)	2.77	3.10		6.19	
S.E. ±	0.97	1.08		2.16	

parameters *i.e*. fruit length, fruit diameter and fruit weight without impairing fruit quality parameters in hasta bahar crop.

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