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RESEARCH PAPER

Use of shoot pruning for crop regulation and quality fruit production of guava (*Psidium guajava* L.)

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Abstract : A field experiment was conducted to see the efficiency of shoot pruning at various length and time on production of off season flowering, fruiting and quality of fruits by avoiding their normal time of flowering. The investigation was carried out on ten years old guava crop cv. LALIT grown at subtropical area of Lucknow, Uttar Pradesh, India with four length (15, 30, 45 and 60 cm of length from tip) of shoot pruning performing in April, May and June based on Randomized Block Design with three replications. The results revealed that among the various pruning treatments pruning at 45 cm length in May, T_8 produced maximum number of leaves (120 days after pruning, 20), flowers (13.67) and fruit yield (14.71 t/ha). Analysis on fruit quality showed that pruning in May at 45 cm length from shoot tip also produced superior quality fruits in term of higher TSS (13.17 ^{0}B), vitamin C (235.17 mg/100g). More interestingly, shoot pruning in general, favoured off season flowering which could help growers to get more profit as compared to normal rainy season fruiting. Thus, the present study suggested that moderate shoot pruning in May at 45 cm length could be the best for off season quality fruiting of guava.

Key Words : Crop regulation, Fruiting, Guava, Shoot pruning

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INTRODUCTION

Off season production of guava is getting popularity worldwide because growers get more profit from offseason cropping having very good quality as compared to rainy season cropping. Guava (*Psidium guajava* L.) a member of Myrtaceae family, is a highly prolific and remunerative fruit crop. Fruits are good source of energy (51-68 calories/100g edible portion), vitamins (A-12 %, C- 200-300 mg/100g), sugars (9 %) and minerals (Sodium-2 mg/100g, Potassium-417 mg/100g, calcium-1 %, iron-1 %) (Mitra and Sanyal, 2004) with dietary fibre (5%) and zero cholesterol. The guava is also called as an apple of tropics and it is the fifth most important fruit of India in respect of area and production after citrus, mango, grapes and banana. Apart from fresh fruits, the fruits are extensively used in the processing industry for making delicious products like jam, jelly and pudding (Shaban and Haseeb, 2009). Though, the fruit yield is high in rainy season (Rathore and Singh, 1974 and Singh *et al*., 2000), but, poor in quality (Maji and Das, 2013 and 2014) due to insipid in taste (Singh *et al*., 1996) and high infestation of pests and diseases (Rawal and Ullasa,

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1988) in comparison to winter season cropping which tasted very good being superior in quality. Guava bears on current season's growth (Singh *et al*., 2000), thus, several methods have been tried to induce new vegetative growth during rainy season so that bumper crop is to be obtained in subsequent winter season (Shigeura and Bullock, 1976 and Singh *et al*., 2000). Bending, a regulation method induces profuse flowering and fruiting as well as fetches greater returns (Ghosh, 2003). Farmers often practice shoot pruning and bending as a tree management strategy to increase new shoot number and induce offseason flowering. Among the several practices, shoot pruning may be helpful in managing tree size and improving fruiting (Haropinder and Bal, 2006). Lal (1983) also indicated that the yield of guava cv. SARDAR was improved by pruning. Various types of summer pruning have been utilized to eliminate vigorous, nonproductive, upright shoots and allow adequate light penetration for the production of quality fruits (Taylor and Feree, 1982). Summer pruning suppresses tree growth by lowering the photosynthetic capacity of the tree, thereby reduceds the carbohydrate reserves (Ferree, 1979 and Rom and Ferree, 1985). Pruning and chemical regulations are popular for off season fruiting but, it may vary region to region and variety to variety. Pruning and hydrogen cyanamid were found to modify the production strategy of guava (Quijada *et al*., 1999). But, mode of pruning and intensity of pruning are varied in different region of crop growing (Salah, 2005) and can produce the highest bud emergence of guava by using severe and moderate pruning. Pruning treatments (10 cm and 20 cm) on guava cv. ALLAHABAD SAFEDA during rainy season produced maximum fruit size, palatability rating, TSS and vitamin C content (Haropind and Bal, 2006). However, the light pruning increased the number of productive branches and number of fruits per branch of guava cv. PALUMA (Serrano *et al*., 2008). Therefore, pruning of guava in one of the most important practices that influence the vigour, productivity and quality of the fruits (Gadgil and Gadgil, 1933). Chemicals were also found to be one of the best methods for off-season production but, considering the health and environmental hazards chemicals should be avoided. On the other hand, shoot pruning might be the safest way to off season production by avoiding chemicals. Crop regulation itself established as very profitable practice for guava cultivators (Maji *et al*., 2015). Thus, keeping these views, the present experiment was conducted with an aim to off season production of quality guava fruits by means of shoot pruning at different time and at different length of shoot.

MATERIAL AND METHODS

Ten years old plants of Guava cv. LALIT planted at 6x6 m spacing at Horticulture Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedker University, Lucknow, Uttar Pradesh, India were selected for the research work. The selected plants were of uniform growth and healthy.

Treatment details :

The experiment was laid out in Randomized Block Design with thirteen treatments replicated thrice *i.e.* thirty nine plants of uniform in growth and in good physical condition were selected. The treatment comprised of four length of shoot pruning (15, 30, 45 and 60 cm) and three pruning time (April, May and June) and unpruned tree were kept as control. The length of shoot pruning was measured from the tip of shoot.

Application of treatments :

The length of shoot pruning (15, 30, 45 and 60 cm) was measured by measuring tape from the tip of shoots. Before pruning, all the leaves and water shoots were removed from the plants. Branches from all directions of the plants in each replication were tagged by aluminium tag for taking observations. The pruning was done by sharp secateurs and pruned on 7th April, 7th May, and 7th June for each length.

After care :

The plants were sprayed with cupper oxychloride (3g/l) immediately after pruning to protect against disease attack. The plants were managed with judicial application of farm compost (20 kg/ plants), watering properly and orchard cleaning was done time to time.

Observations taken :

The observations were recorded for its change in vegetative growth, flowering, fruiting and physico-chemical quality of guava fruits. The vegetative growth parameters in respect of number of leaves were recorded and presented in this paper. The observations were taken from 15 days after pruning (DAP) upto 120 DAP at 15 days interval. After harvest, the fruit physical characters

in term of fruit weight, fruit size (length and diameter), fruit volume, specific gravity of fruits, pulp weight, number of seeds per fruit, weight of seeds per fruit, weight of 100 seeds etc were calculated by following standard methods. The quality parameters like TSS, reducing sugar, non- reducing sugar, total sugars, Vit. C, TSS: acid ratio and sugar: acid ratio was determined with standard procedures as suggested by A.O.A.C. (2000).

Statistical analysis :

The observed data were analysed statistically as stated by Sahu and Das (2014) in Office Excel worksheet with the principle of Randomized Block Design. The treatment effects were compared at 5 per cent level of significance by reviewing their mean values as presented on various tables and figures.

RESULTS AND DISCUSSION

The effect of shoot pruning on production of leaves of newly emerged shoots after pruning were varied at different days (starting from 15 DAP to 120 DAP) at 15 days interval under different treatments (Table 1). At 15 DAP, all the treatments showed higher increase in number of leaves as compared to unpruned control plants. Among them, treatment T_4 (pruning at 30 cm length in April), T_5 (pruning at 30 cm in May) and treatment T_8 (pruning at 45 cm in May) produced the highest number of leaves per new shootlet (3.67, 3.67 and 3.67, respectively at 15 DAP) followed by T_6 (pruning at 30 cm in June), T_7 (pruning at 45 cm in May) and T_{10} (pruning at 60 cm in April) and the lowest leaves (2.67) were counted under control (T_0) (2.67) and T_3 (2.67). Similar pattern of increase in number of leaves per shootlet was also observed upto 120 DAP where maximum number of leaves (20) was recorded under plants when pruned at 45 cm length in May (T_8) whereas, the lowest number of leaves (15.33) at control (T_0). In general, more number of leaves was counted in pruned tree than the unpruned control plants. The pruning in the month of May and April at 30 cm of length produced more number of leaves per new shootlet as compared to pruning in June. The pruning operation might shift the reserved food materials and enhanced vegetative growth *i.e.* number of leaves per shootlet in this experiment (Singh *et al*., 2001).

Although, T_7 showed early flowering (data not presented here) but, it did not produced maximum flowers per shootlets (Table 2). It was the treatment T_8 (pruning at 45 cm in May) which produced the highest number of flowers per shootlet (13.67) followed by T_5 (12.33) and the minimum (6.00/shootlet) was recorded under unpruned control.

The fruit set percentage was determined by considering the number of flower per shootlet and number of flowers drop per shootlet at particular period and was marked properly. The data presented in Table 3 showed that 15 cm pruning in May (T_2) showed much

Table 1 : Effect of shoot pruning on number of leaves per shootlet in guava

	Day after pruning (DAP)							
Treatments	15 D	30 D	45 D	60 D	75 D	90 D	105 D	120 D
T_0 – Control	2.67	4.67	6.33	7.67	9.33	11.33	13.33	15.33
T_1 – 15 cm pruning in April	3.00	6.00	8.33	10.33	12.33	14.33	16.33	18.33
T_2 - 15 cm pruning in May	3.00	6.33	8.67	10.67	12.67	14.67	16.67	18.67
T_3 - 15 cm pruning in June	2.67	6.00	8.67	10.67	12.67	14.67	16.33	18.33
T_4 - 30 cm pruning in April	3.67	6.33	8.33	10.33	12.33	14.33	16.33	18.33
T_5 - 30 cm pruning in May	3.67	6.00	8.00	10.00	12.00	14.00	16.00	18.00
T_6 - 30 cm pruning in June	3.33	6.00	8.33	10.33	12.33	14.33	16.33	18.33
T_7 - 45 cm pruning in April	3.33	6.33	8.33	10.33	12.33	14.33	16.33	18.33
T_8 - 45 cm pruning in May	3.67	7.00	9.00	12.00	14.00	16.00	18.00	20.00
T_9 - 45 cm pruning in June	3.00	6.00	8.00	9.00	11.00	13.00	15.00	17.00
T_{10} - 60 cm pruning in April	3.33	5.67	7.67	10.67	12.67	14.67	16.67	18.67
T_{11} - 60 cm pruning in May	3.00	5.33	7.33	9.33	11.33	13.33	15.33	17.33
T_{12} - 60 cm pruning in June	3.33	5.33	7.67	10.00	12.00	14.00	16.00	18.00
S.E.±	0.518	0.680	0.870	0.797	0.795	0.795	0.721	0.792
C.D. (P=0.05)	1.07	1.40	1.80	1.65	1.64	1.64	1.49	1.63

higher fruits set (69.64 %) than the other treatments. The shoot pruning at 30 cm in May (T_5) showed the lowest fruit set percentage (53.60 %), even lower than control (61.27 %). The fruit retention was determined by considering number of mature fruits per plant from initial fruit set per plant. The highest fruit retention (71.99 %) was observed in T_8 (pruning at 45 cm in May) and the minimum (62.73 %) was recorded under T_{12} (pruning at 60 cm in June), which ultimately increased the fruit yield (Fig. 1). The pruning in May (30 and 45 cm length of pruning) produced more flowers than the others. The moderate pruning *i.e.* 15, 30 and 45 cm of length in May increased the fruit set percentage as well as fruit retention of guava. Brar *et al*. (2007) also reported the similar pattern of increase in fruit set and reduced flower drop. The better performance of moderate pruning might be due to balance between vegetative and reproductive growth of guava. Ali and Abdel Hameed (2014) and Lotter *et al*. (1990) also reported that pruning at May gave the significantly highest flowering and fruiting in old seedy guava grown in Egypt. Bagchi *et al*. (2008) stated that the lipid content was higher in bark at initial stage and in leaves at later stage to overcome the shock effect of pruning. They also demonstrated that increase in catalase, peroxidase and polyphenol oxidase activity as the use of self-defensive mechanism after pruning which stimulated stress condition ultimately initiation of profuse flower buds.

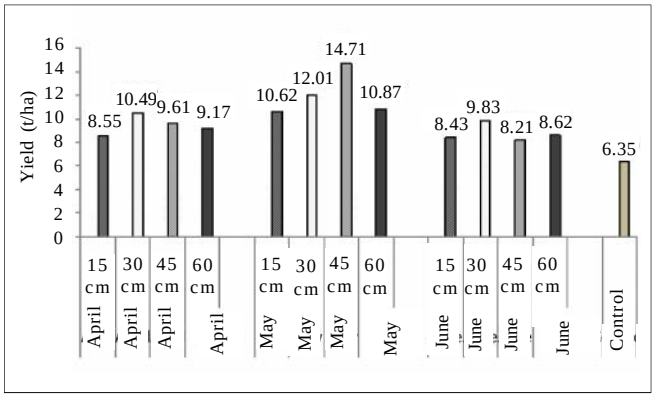

Fig. 1 : Fruit yield as influenced by pruning treatments in guava

Pruning at 45 cm in May (T_8) also recorded the highest average fruit weight (213.59g) followed by T_5 (pruning at 30 cm in May) and minimum in control (T_0) (130.97g). The fruit size (length and diameter) in pruning plants was also found higher than unpruned control (Table 3). The maximum fruit length (6.20 cm) was recorded in T_8 (pruning at 45 cm in May) and lowest observed in control (T_0) unpruned plant. Similarly, the diameter of fruits in pruned plants T_8 (pruning at 45 cm in May) was also higher (6.20 cm). It also showed the highest fruit volume as well as specific gravity of guava fruits followed by T_{10} (pruning at 60 cm in April) and T_{11} (pruning at 60 cm in May). Among the three pruning intensity studied, maximum pulp weight (99.33g) was recorded with moderate pruning of 45 cm length in May (T_8). There was a positive correlation between fruit yield and fruit weight but, after certain level the fruit yield was not increased so much with the rate of increase in average fruit weight (Fig. 2).

The increase in fruit size after summer might be

Table 2: Effect of shoot pruning on flowering and fruiting of guava

Treatments	Flower number per shootlet	Fruit set (%)	Fruit set number per plant	Fruit retention (%)
T_0 – Control	6.00	61.27	250	68.72
T_1 – 15 cm pruning in April	7.00	56.55	258	71.70
T_2 - 15 cm pruning in May	7.67	69.64	325	65.83
T_3 - 15 cm pruning in June	7.67	61.57	257	67.51
T_4 - 30 cm pruning in April	10.67	59.85	270	73.30
T_5 - 30 cm pruning in May	12.33	53.60	325	67.47
T_6 - 30 cm pruning in June	7.33	68.06	269	71.76
T_7 - 45 cm pruning in April	8.83	60.35	275	70.78
T_8 - 45 cm pruning in May	13.67	56.63	345	71.99
T_9 - 45 cm pruning in June	8.00	67.33	263	69.83
T_{10} - 60 cm pruning in April	9.67	55.16	270	65.91
T_{11} - 60 cm pruning in May	10.00	61.11	306	66.31
T_{12} - 60 cm pruning in June	9.67	59.02	265	62.73
S.E.±	1.494	3.568	14.130	4.108
C.D. (P=0.05)	3.08	7.98	29.16	8.48

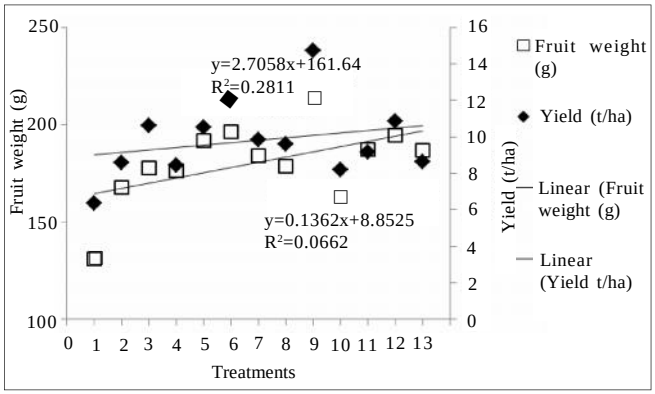

Fig. 2 : Correlation between fruit weight and fruit yield

due to more accumulation of carbohydrates and food reserve at comparatively low temperature in winter causing production of bigger sized fruits although higher crop load (fruit yield) was recorded during winter. The successful increase of fruit size and volume with pruning at 45 cm in May over control was due to enlargement of cell size or increase in number of cells *i.e.* increase in cell volume as viewed by Leopold (1958). After hot summer all the food reserve got diverted for the fruit development which caused increase in fruit weight along with pulp. Similar increase in fruit weight, size and pulp in winter by summer crop regulation was also reported by Sahay and Singh (2001); Dubey *et al*. (2002); Sahay and Kumar (2004) and Dutta and Banik (2006). Naturally, fruit in winter season also showed higher specific gravity because in winter the tissues are more compact and intercellular spaces are less. So, the rate of increase in volume was less than the rate of increase in weight which resulted increase in specific gravity.

Among the effect on seed content, it was observed that the number of seeds per fruit, seed weight per fruit were maximum under treatment T_8. However, 100 seed weight (seed index) was higher under T_7 (pruning in April at 45 cm length). Although, less number of seed per fruit is desirable by the consumer, but in our experiment the best treatment (T_8) also increased the seed number and seed weight. The seed characters are also associated with fruit growth and development as seed indirectly influence the internal physiological processes determining the fruit quality (Maji *et al*., 2015).

Among the fruit quality parameters (Table 4) TSS was recorded maximum under T_8 (pruning at 45 cm in May) (13.17 ^oBrix) followed by T_4 (pruning at 30 cm in April) (12.27 ^oBrix) and the lowest was in unpruned control T_0 (9.20 0Brix). Similarly, vitamin C content (Fig. 3) was observed maximum under T_8 (235.17 mg/100g) but, total sugars was maximum (11.37 %) under T_2 (pruning at 15 cm in May) followed by T_8 (pruning at 45 cm in May) and non-reducing sugar under T_8 (pruning at 45 cm in May). As a result, T_8 recorded maximum sugar: acid and TSS: acid ratio (26.89 and 21.41, respectively) (Fig. 4) compared to treatment T_2 (pruning at 15 cm in May) and the lowest was recorded in unpruned plant T_0 (13.79). The appreciable improvement in total soluble solids (TSS) and total sugars for various pruning treatments might be due to quick metabolic transformation of starch into sugar and rapid mobilization

Table 3: Effect of shoot pruning on morpho-physical characteristics of guava

Treatments	Weight of fruit (g)	Length of fruit (cm)	Diameter of fruit (cm)	Volume of fruit (ml)	Fruit specific gravity(g/cc)	Pulp weight (g)	Seed weight per fruit (g)	Number of seed per fruit	100 seed weight (g)
T_0 – Control	130.97	5.03	4.12	42.44	1.09	63.19	12.76	299.67	4.26
T_1 – 15 cm pruning in April	167.53	5.79	5.71	97.89	1.20	74.71	13.03	307.67	4.24
T_2 - 15 cm pruning in May	177.82	5.36	5.33	90.55	1.18	92.74	13.32	312.00	4.28
T_3 - 15 cm pruning in June	176.27	4.99	5.36	84.67	1.20	91.42	13.51	318.00	4.25
T_4 - 30 cm pruning in April	191.55	5.47	5.47	95.60	1.17	80.26	13.42	321.00	4.18
T_5 - 30 cm pruning in May	196.39	5.58	5.33	81.74	1.11	93.59	13.72	326.00	4.21
T_6 - 30 cm pruning in June	183.94	5.76	5.83	128.33	1.07	95.40	12.99	304.67	4.26
T_7 - 45 cm pruning in April	178.58	5.43	5.24	86.94	1.08	94.40	12.83	290.00	4.46
T_8 - 45 cm pruning in May	213.59	6.29	6.20	146.43	1.40	99.33	14.05	335.33	4.19
T_9 - 45 cm pruning in June	162.40	5.20	5.12	78.00	1.07	92.65	12.59	289.00	4.36
T_{10} - 60 cm pruning in April	187.11	5.65	5.76	126.11	1.24	91.93	11.79	283.00	4.18
T_{11} - 60 cm pruning in May	194.55	5.82	5.50	98.00	1.24	94.85	12.84	294.67	4.36
T_{12} - 60 cm pruning in June	186.89	5.58	5.54	107.11	1.08	95.77	13.71	321.67	4.26
S.E.±	18.458	0.164	0.354	22.262	0.158	9.363	0.825	26.078	0.092
C.D. (P=0.05)	38.10	0.34	0.73	45.95	0.33	19.33	1.70	53.82	0.19

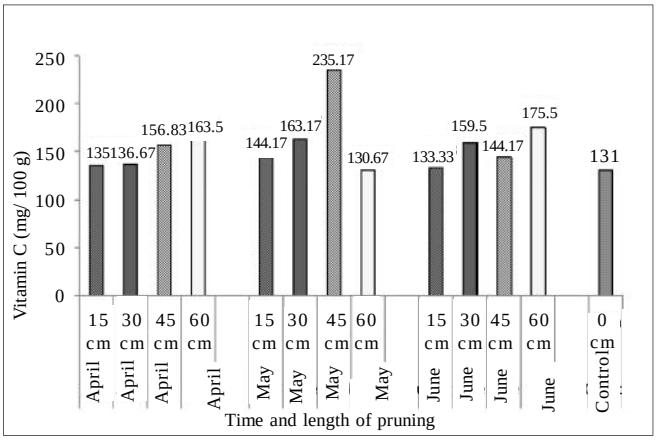

Fig. 3 : Effect of pruning on vitamin C content of guava

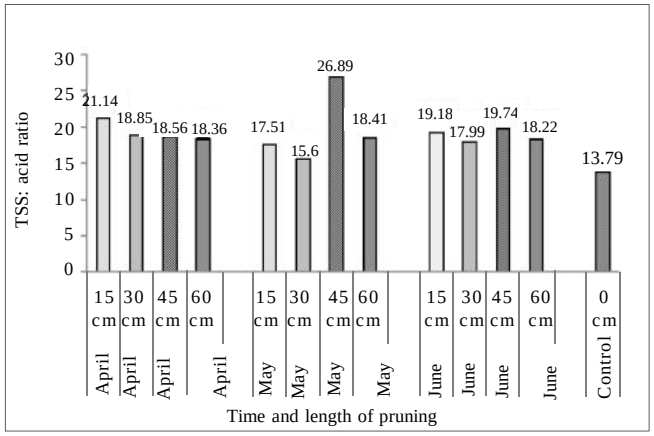

Fig. 4 : TSS: acid ratio of guava fruits affected by various pruning treatements

of photosynthetic metabolites and minerals from other parts of plant to the developing fruits. The improvement in vitamin C content was probably due to the aftershock of pruning on bio- synthesis of ascorbic acid and or growth substances which might inhibit the activities of oxidative enzymes. The similar trend was also found by Singha (2004) during fruit growth study in rose apple, winter apple and carambola (Das *et al*., 2006). The decreasing trend in acidity with shoot pruning might be due to the faster degradation of organic acids. It might have either been quickly converted into sugars or their derivatives by the reaction involving reversal of glycolytic pathway or consumed in respiration or both. The increase in TSS, sugar content and decrease in acidity with the treatments resulted the maximum TSS: acid and sugar: acid ratio, recorded in the present study. The similar improvement in fruit quality of guava through summer crop regulation had also been reported by Dubey *et al*. (2002); Sahay and Kumar (2004); Dutta and Banik (2006); Tiwari and Lal (2007) and Singh (2007). It was seen that the vitamin C content was correlated with fruit yield (Fig. 5) but, the relation between TSS:acid ratio and Vitamin C was not proportionate.

It was also assessed that the time of flowering and harvesting of fruits were influenced very much with different shoot pruning treatments at several months and various length (Fig. 6). The figure showed that shoot pruning caused early flowering than the control which might be the self defensive mechanism of crop after pruning shock. Among the treatments pruning at 15 cm in May showed early flowering due to rise of temperature. Generally, it took 41.67 (≈ 41) days to 51.33 (≈51) days to flower from new shoot emergence, whereas, 126 days to 149 days for harvesting from

Table 4 : Bio-chemical quality of fruits as influenced by shoot pruning treatments on guava

Treatments	TSS of fruit (°Brix)	Total sugars (%)	Non-reducing sugar (%)	Acidity (%)	Reducing sugar (%)	Sugar : acid
T_0 – Control	9.20	7.83	1.44	0.667	6.39	11.76
T_1 – 15 cm pruning in April	9.73	9.38	2.16	0.464	7.22	20.86
T_2 - 15 cm pruning in May	10.60	11.37	2.47	0.605	8.90	18.82
T_3 - 15 cm pruning in June	11.93	9.67	2.20	0.627	7.47	15.47
T_4 - 30 cm pruning in April	12.27	9.65	2.03	0.662	7.62	14.91
T_5 - 30 cm pruning in May	10.00	11.07	2.14	0.643	8.93	17.26
T_6 - 30 cm pruning in June	11.13	10.41	2.24	0.620	8.17	16.83
T_7 - 45 cm pruning in April	12.03	10.00	2.40	0.649	7.60	15.44
T_8 - 45 cm pruning in May	13.17	11.20	2.52	0.493	8.68	22.87
T_9 - 45 cm pruning in June	12.17	9.05	2.40	0.632	6.64	14.91
T_{10} - 60 cm pruning in April	11.67	8.97	2.33	0.641	6.64	14.09
T_{11} - 60 cm pruning in May	11.67	8.27	2.30	0.636	5.97	13.01
T_{12} - 60 cm pruning in June	11.50	9.17	2.03	0.634	7.14	14.46
S.E.±	1.298	0.340	0.108	0.102	0.585	1.353
C.D.(P=0.05)	2.68	0.70	0.22	0.21	1.21	3.46

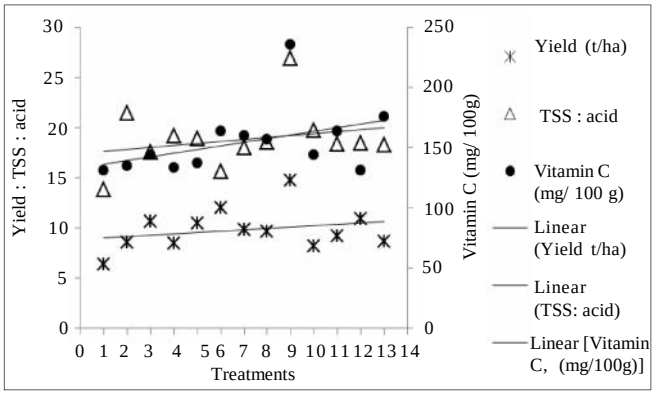

Fig. 5 : Relation between fruit yield, vitamin C and TSS: acid of guava

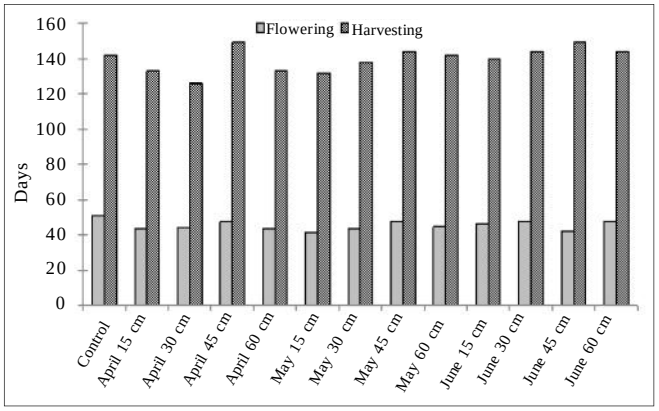

Fig. 6 : Days taken to flowering from new shoot emergence and days taken for harvesting from flowering

flowering. Though, early flowering was recorded under pruning at 15 cm in May the fruits matured early under 30 cm pruning in April and late harvesting was done in treatments of 45 cm pruning in April and 45 cm pruning in June. Early harvesting in April pruning might be due to the fact that the fruits development stage coincide with high temperature which enables speedy physiological development.

From the study it can be concluded that the pruning might be a good technique for effective crop regulation without any chemical hazards and among the pruning studied the 45 cm shoot pruning in May could be the best for successful crop regulation, good fruiting and better quality.

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