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Standardization of pruning for high density Sardar guava orchards under hot and humid climate of Eastern India

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ABSTRACT

Response of guava to three levels of winter and summer pruning (30, 50 and 70%) was studied in a trial conducted during 2014-16 on eight-year-old guava plants spaced at 2.5 m × 1.25 m. In general, pruning encouraged shoot emergence, irrespective of time and intensity, however, winter pruning resulted in production of more shoots or laterals (27.02 ± 3.85 shoots/m of branch) as compared to treatments of summer pruning (14.55 ± 3.3). Shoot emergence increased with the severity of pruning. Shoot pruning during winters was found effective in enhancing flowering intensity (38.58 ± 4.25%), fruit set (73.68 ± 0.48%) and fruit yield (6.12 ± 1.13 kg/ plant), whereas, summer pruning did not show significant influence on these parameters. Among three treatments of winter pruning, 70% shoot pruning was the best treatment and recorded the maximum values for flowering intensity (42.83%), fruit set (74.15%) and fruit yield (7.25 kg/plant or 23.2 t/ha). The same treatment recorded the highest cumulative yield of rainy and winter season (8.65 kg/plant or 27.68 t/ha) as well. With respect to fruit quality, all the pruning treatments recorded significant improvement in total soluble solids and vitamin C contents for both rainy and winter season crops over the control. However, differences remained at par among all the pruning treatments. The treatment 70% shoot pruning during summer yielded fruits with maximum TSS and vitamin C content in both the crops *i.e.*, rainy and winter season. Thus, it can be concluded that under hot and humid climate of Odisha, high density guava orchards could be pruned during winters at 70% intensity to realise high yield potential of guava in the region.

Key words: *Psidium guajava*, high density orcharding, quality, shoot pruning, yield.

INTRODUCTION

Guava (*Psidium guajava* L.) belonging to family Myrtaceae is the fifth most important fruit crop in India after mango, citrus, banana and apple in terms of area. Owing to its hardy nature, wider edapho-climatic adaptability, high production potential, nutritional, and processing values, it is cultivated throughout the tropical and sub-tropical parts of the country. Over the last 25 years (1991-2015), India has recorded 3.7-fold increase in production (1.1 to 4.05 million tonnes) primarily due to 171.17% increase in area (94 thousand to 2.55 lakh ha). However, on productivity front guava cultivation has not shown significant improvement. Reason being, at present it is mainly cultivated using conventional system of planting accommodating 200 to 400 plants/ha only. It is very difficult to achieve desired level of productivity in guava under such low plant density, as commercial bearing starts only after 5-6 years of plantation (Joshi *et al.*, 6). Besides, large trees provide low production per unit area and need high labour inputs. The challenge of low productivity levels in guava could be addressed by adoption of high density orcharding (HDO). This system of orcharding not only provides higher yield, but also provides higher net economic returns per unit area in the initial years and also facilitates more efficient use of natural resources and agri-inputs (Lal *et al.*, 13). Depending upon the spacing, genotype and agro-climatic conditions of growing area high density orchards become overcrowded after 5-7 years of plantation in the absence of proper canopy management. In the absence of sufficient exposure to light, the leaves located in the deeper layers of canopy become photosysnthetically inactive and act as unproductive sink. This leads to disturbance in source-sink relationships and as a result major proportion of plant canopy remains unfruitful. Moreover, restricted distribution of solar radiation and circulation of air inside the dense canopy, build up the microclimate congenial for pests and diseases. All these contribute towards low fruit yield and poor quality of the produce. Hence, success of HDO essentially requires manipulation in canopy to facilitate better light penetration inside the canopy. Crops that respond well to pruning are considered ideal for HDO. Bearing habit of guava makes it amenable to pruning and ideal candidate for HDO, as it bears flowers in the axils of new leaves.

Investigations pertaining to standardization of time and intensity of pruning in guava for its high

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density orcharding have been reported mainly from North Indian states with distinct winters (Lal *et al*., 12; Lal *et al*., 13; Singh *et al*., 19; Kumar and Rattanpal, 8; Pratibha *et al*., 16; Joshi *et al*., 5; Kumar *et al*., 7). Few documentations have also been made from hot and dry tropical regions of South India (Lakhpathi *et al*., 11; Lakpathi and Rajkumar, 10) and sub-tropical region of North-West India (Kumawat *et al*., 9). However, such information is lacking for hot and humid regions of eastern India in general, and Odisha, in particular. Keeping this in view, the present investigation was carried out.

MATERIALS AND METHODS

The experiment was carried out at ICAR-IIHR-Central Horticultural Experiment Station, Bhubaneswar, Odisha in the high density orchard (2.5 m x 1.25 m) of eight-year-old guava cv. Sardar, during 2014-16. The experimental site is situated at 20°15' N latitude and 85°15' E longitude at an elevation of 25.5 m above mean sea level. The climate of experimental farm is hot humid tropical, which receives on an average 1400 mm annual rainfall between June to September. The red lateritic soil of experimental site is strongly acidic (pH 4.4-4.6), low in organic carbon (0.2%), nitrogen (180.5 kg/ha) and phosphorus (8.1 kg/ha), and medium in potassium (190.5 kg/ha). The experiment was laid out in randomized block design with seven treatments. Each treatment was replicated four times and each replication unit comprised of 10 plants. The treatments were T_1: Control (no pruning), T_2: 30% winter shoot pruning, T_3: 50% winter shoot pruning, T_4 : 70% winter shoot pruning, T_5: 30% summer shoot pruning, T_6: 50% summer shoot pruning, and T_7: 70% summer shoot pruning. Winter pruning was done in December, whereas, summer was in May.

Observations on flushing (No. of shoots emerged, length of flowering and non-flowering shoots), leaf chlorophyll content, flowering and fruiting (flowering intensity, fruit set, and fruit drop), yield, and fruit quality parameters (total soluble solids, acidity, and vitamin C) were recorded for both the crops *i.e.*, rainy and winter. In case of control trees, four branches (one in each direction of canopy) were selected randomly for recording observations on shoot emergence, while, in case of pruning treatments, a total of 20 pruned shoots (five in each direction of canopy) were selected. Total number of shoots emerged during winter and summer were counted and expressed as no. of shoots emerged /m of branch or shoot length. For estimation of chlorophyll content, 20 non-flowering shoots of five- month-old maturity were selected in each tree (5 shoots in each direction of plant canopy). Thereafter, chlorophyll content of 4^{th} leaf pair (from the base of shoot) was measured with the help of chlorophyll meter (atLEAF) on 5 points avoiding mid-rib area. Direct sunlight was avoided while taking the observations. Chlorophyll content was expressed in chlorophyll index (atLEAF value).

Flowering intensity was determined by counting the numbers of flowering shoots emerged on the selected branches or pruned shoots, and expressed in percentage. To record observations on shoot growth, fruit set, and fruit drop, 20 flowering and 20 non-flowering shoots were tagged in each plant (5 flowering and 5 non-flowering shoots in each direction of canopy). Shoot length was measured after 180 days of emergence. Fruit set and fruit drop were also computed; Fruits were harvested at full maturity, counted and weighed with physical balance, and yield was expressed in kg/ tree. Average fruit weight was computed by dividing the yield obtained from the tree by the number of fruits obtained. Ten mature fruits from each replication unit were taken randomly for recording observations on various chemical attributes of fruit quality. Total soluble solids content (TSS) was determined using hand- held digital refractometer (Hanna). Acidity was estimated by titrating fresh fruit juice with 0.1N NaOH using phenolphthalein as indicator and expressed as per cent citric acid equivalents. Vitamin C was determined as per the method described in AOAC (1). The data generated on various parameters during three consecutive years, were pooled and statistically analyzed using OPSTAT package of Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana for interpretation of results and drawing conclusion.

RESULTS AND DISCUSSION

Influence of pruning on characteristics of flushing (No. of shoots emerged and length of flowering and non-flowering shoots) is depicted in Fig. 1. In general, production of new shoots in guava was encouraged due to pruning, irrespective of time and intensity, however, winter pruning treatments (T_2, T_3 and T_4) resulted in emergence of more shoots or laterals as compared to summer pruning treatments (T_5, T_6 and T_7). It was also observed that flushing or shoot emergence increased with the severity of pruning. Maximum numbers of laterals were emerged with 70% intensity of pruning during both the seasons of flushing *i.e.*, spring and rainy flushing. The beneficial influence of pruning on shoot emergence could be explained by the fact that under HDO system plants tend to grow upright in search of light and produces limited numbers of laterals due to the botanical phenomenon of apical dominance, wherein, lateral buds become dormant or latent under the

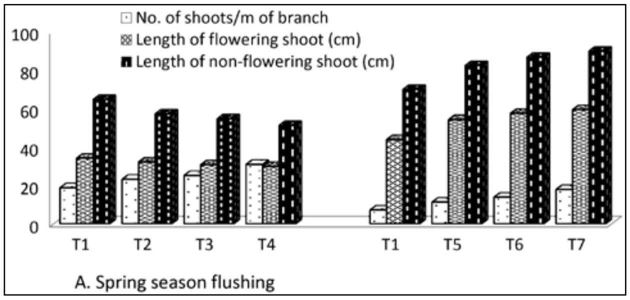

Fig. 1. Effect of winter and summer pruning on characteristics of flushing in guava cv. Sardar.

influence of plant hormone known as auxin. Pruning might have diluted the inhibitory effect of auxin on lateral buds through elimination of shoot portion where auxin synthesis takes place *i.e.*, apical buds. Response of guava in terms of shoot growth varied with the time of pruning. Winter pruning treatments resulted in production of shorter shoots as compared to control, whereas, summer pruning treatments produced longer shoots. Influence of winter pruning on containment of shoot growth was found to be more pronounced in non-flowering shoots than in flowering shoots. However, both types of shoots showed similar trend of enhanced shoot shortening with increase in pruning intensity. Shortest shoots were observed at 70% intensity (T_4). Production of more number of shoots in winter pruned trees could have reduced the share of nutrients and water supplies in the newly emerged shoots, which in turn might have resulted in reduced shoot growth as compared to un-pruned trees with less numbers of shoots under identical condition. In contrary to winter pruning, summer pruning exhibited positive influence on growth of rainy season flush. The length of flowering and non-flowering shoots increased with the severity of summer pruning, however, differences were found to be non-significant. The longest non-flowering (89.67 cm) and flowering shoots (59.31 cm) were observed in 70% shoot pruning (T_7). These results are in agreement with the findings of Lakpathi *et al*. (11), Agnihotri *et al.* (2) and Kumar *et al*. (7). Summer pruning could have brought dawn the carbohydrate reserves of plant to such a level that plant forced itself to produce vigorous shoots in an effort to bring the C: N ratio at optimal level.

Flowering and fruiting response of guava to various pruning treatments (Table 1) revealed that winter pruning (T_2, T_3 and T_4) caused a significant improvement in flowering intensity and fruit set for rainy season crop as compared to control and summer pruned trees (T_1, T_5, T_6 and T_7). Among three intensities of winter pruning, 70% shoot pruning (T_4) recorded the maximum values for flowering intensity

Table 1. Flowering and fruiting of guava cv. Sardar under high density orcharding system as influenced by pruning.

Treatment	Flowering intensity (%)		Fruit set (%)		Fruit drop (%)	
	R	W	R	W	R	W
T_1	25.87	9.50	63.92	60.96	64.39	56.39
T_2	34.33	8.74	73.20	62.50	58.23	53.90
T_3	36.10	9.15	71.06	63.46	57.52	52.35
T_4	42.83	8.49	74.15	64.03	57.45	53.73
T_5	24.02	8.20	61.35	62.84	62.20	53.57
T_6	26.61	8.18	62.77	61.63	60.64	52.31
T_7	25.96	10.51	64.03	63.87	63.44	53.40
CD at 5%	5.1	NS	6.52	NS	4.92	NS

T_1: No pruning, T_2: 30% winter shoot pruning, T_3: 50% winter shoot pruning, T_4: 70% winter shoot pruning, T_5: 30% summer shoot pruning, T_6: 50% summer shoot pruning, T_7: 70% summer shoot pruning, R: Rainy season crop, W: winter season crop.

(42.83%) and fruit set (74.15), whereas, shoot pruning at 30% intensity recorded the minimum values (34.33 and 73.20) for the respective parameters. Perusal of data in Table 1 further showed significant reduction in fruit drop of rainy season crop by all the treatments of winter pruning. Minimum fruit drop was recorded with 70% shoot pruning (T_4) followed by 50% (T_3). In our study, summer pruning did not brought desirable changes in flowering and fruiting parameters of winter season crop, *viz*., enhancement in flowering and fruit set, reduction in fruit drop, as against reported by Singh *et al.*(18), Pilania *et al*. (14), and Joshi *et al*. (6).

In present study, out of three treatments of winter pruning, T_3 and T_4 were found to bring significant enhancement in rainy season crop load (Table 2). The treatment T_4 recorded maximum values for No. of fruits/tree and fruit yield (7.25 kg/tree). The same treatment recorded the maximum cumulative yield of both rainy and winter seasons (8.65kg/tree or 27.68 t/ha) as well. On the other hand, none of the summer pruning treatments succeeded in enhancing the share of winter season crop, in spite of causing significant reduction in crop load of rainy season. Rather, resulted in significant loss of total crop yield over un-pruned and winter pruned trees. However, summer pruning improved the fruit weight significantly in both the crops. The increase in fruit weight in summer pruned trees might be due to the availability of metabolites and water in abundance to a relatively less number of fruits and high leaf to fruit ratio as opined by Kumar and Rattanpal (8), Prakash *et al.* (15) and Lakpathi *et al.* (11). Both, winter and summer pruning were found beneficial to guava with respect to making significant improvement in two important

Table 2. Yield and fruit quality of guava cv. Sardar under high density orcharding system as influenced by pruning.

Treatment	Yield (kg/tree)			No. of fruits/ tree		Av. fruit wt. (g)		TSS (°B)		Acidity (%)		Vitamin C (mg/100 g pulp)	
	R	W	Total	R	W	R	W	R	W	R	W	R	W
T_1	4.30	1.19	5.49	30.31	6.97	141.77	170.23	8.58	9.08	0.44	0.41	168.83	182.11
T_2	4.99	1.18	6.16	34.64	6.60	142.63	177.90	9.13	9.65	0.46	0.44	176.22	191.56
T_3	6.20	1.33	7.53	41.77	7.37	148.96	179.60	9.28	9.80	0.42	0.45	176.27	192.65
T_4	7.25	1.08	8.65	49.85	6.02	145.65	178.86	9.33	9.92	0.42	0.43	179.13	194.02
T_5	3.25	1.28	4.53	21.14	6.97	153.83	184.59	9.25	9.80	0.40	0.44	174.69	193.06
T_6	2.99	1.35	4.34	19.12	7.24	156.20	186.63	9.51	9.98	0.43	0.45	177.85	195.68
T_7	2.35	1.60	3.95	14.83	8.52	158.58	187.53	9.65	10.08	0.42	0.44	181.39	199.38
CD at 5%	0.72	NS	0.78	5.33	NS	7.79	8.96	0.52	0.45	NS	NS	6.74	8.55

T_1: No pruning, T_2: 30% winter shoot pruning, T_3: 50% winter shoot pruning, T_4: 70% winter shoot pruning, T_5: 30% summer shoot pruning, T_6: 50% summer shoot pruning, T_7: 70% summer shoot pruning, R: Rainy season crop, W: winter season crop.

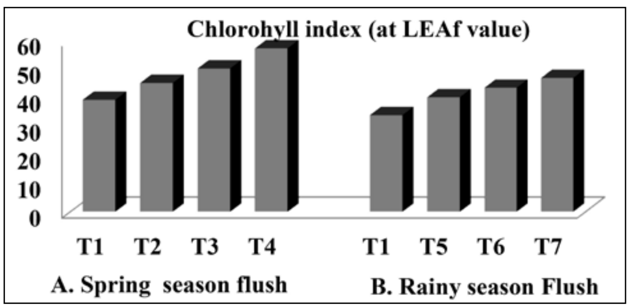

Fig. 2. Effect of winter and summer pruning on leaf chlorophyll content.

chemical parameters of fruit quality *i.e.*, TSS and vitamin C content. In general, TSS and Vitamin C followed an increasing trend with the increase in pruning intensity. However, among all the treatments of pruning differences remained at par. Pruning treatment T_7 recorded the maximum values for TSS and vitamin C contents for both rainy and winter season crops. These results are in line with the finding of Kumar *et al.* (7), Brar *et al.* (4), and Bhagawati *et al.* (3). Improvement in fruit quality (TSS and vitamin C content) may be due to better light penetration inside the canopy of winter and summer pruned trees, which might have led to enhancement in photosynthesis and accumulation of carbohydrates. Chlorophyll content, an indicator of photosynthetic efficiency was also found to be more in pruned trees than un-pruned trees (Fig. 2). Perusal of fruit quality data further revealed that time of pruning had significant effect on quality of harvest. Fruits harvested during winter season had better TSS and vitamin C content than the fruits harvested during rainy season. Low temperature and low moisture content in the soil profile during winter could be responsible for the better quality of winter season crop as opined by Singh and Dhaliwal (17), and Prakash *et al.* (15). As far as fruit acidity is concerned, no significant changes were observed among the treatments.

It is very clear from the present study that under hot and humid climate of Odisha, pruning may not be a suitable strategy for crop regulation (shifting harvest peaks during winter season) in high density orchards of guava, however, could be utilized to realise high yield potential of guava under HDO by enhancing the rainy season crop. Hence, it is concluded that high density orchards of guava may be pruned during winter at 70% severity to enhance productivity of guava in the region.

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