Crop Regulation in Guava: A Review

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ABSTRACT

Guava (Psidium guajava L.) is one of the most promising fruit crops of India and is considered to be one of the exquisite nutritionally valuable and remunerative crops. It has gained considerable prominence on account of its high nutritive value, cheap and easily availability at moderate prices. Guava fruits are considered the king of fruits, though the fruit is not poor in its nutritive or commercial value. It is a hardy, prolific bearer and highly remunerative fruit crop which grown widely in tropical and sub-tropical regions and succeeds under a wide diversity of climatic conditions. Fruit setting and fruit development are poor if the temperatures are high and humidity is low. Under tropical climate due to availability of sufficient heat and moisture, produce fruit almost continuously. However, in sub-tropical climate three distinct periods of growth and fruiting are occurred. There are Ambe bahar- February to March flowering and fruit ripens in July – August, Mrig bahar – June to July flowering and fruit ripens October to December and Hast bahar – October to November flowering and fruit ripens in February to April (Shukla et al. 2008). Continuous bearing results in reduction of yield with small size fruits. Hence, for commercial production it is advisable to take only one crop in the main season during which the quality of fruits is also good.

Crop regulation

In guava, floweringso in more in summer season (Ambe bahar) due to the break of winter stress that leads to more fruit production in rainy season. But, in this season due to high temperature and rainfall during fruit maturation, the duration of maturation is reduced to 30 days that causes glut in the market, whereas winter season crop (Mrig bahar) is superior in quality which fetches comparatively higher price. Although, the production is surplus in rainy season (Rathore and Singh, 1974 and Singh et al., 2000), it offers poor quality due to insipid in taste and infestation of pest (Rawal and Ullasa, 1988) in comparison to winter season. On the contrary, in winter season quality fruits are produced with good quality and fetch high monetary returns (Singh et al., 2000). Guava fruit harvest peaks can deviate with prevailing weather conditions and cultural practices because flowers are produced on new growth. So, it is advisable to take only winter season crop every year. This requires crop regulation to obtain the most desirable crop, by the methods like withholding irrigation, thinning of flowers by chemically or manually, pruning, bending, root exposure, etc. The basic principle of crop regulation is to manipulate the natural flowering and fruiting of guava plant in desired season of the year that contribute to increased fruit yield, quality, profitability and sustainability of the environment by reducing the use of the frequency of the pesticides (Mahadevan and Kumar, 2014).

The selection of bahar at a location is mainly determined by

- Availability of the irrigation water
- Market value and demands
- Quality of fruits

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(2019). Crop Regulation in Guava: A Review, Agricultural Reviews, 40(4): 303-308.

How to cite this article: Anop Kumari and Mahesh Choudhary

Source of support: Nil

Conflict of interest: None

Submitted: 09-09-2019 Accepted: 28-11-2019 Published: 09-12-2019
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- Occurrence and extend of the damage by the insect, pest and disease
- Climate of the area
- Availability of fruit in the market
- Comparable yields

METHODS OF CROP REGULATION IN GUAVA

Several methods have been tried to induce new vegetative growth during rainy season so that bumper crop is obtained in subsequent winter season (Singh et. al., 2000). The work carried out by various scientists on crop manipulation is reviewed under different sub heads.

Crop regulation by shoot pruning

One of the critical characteristics of guava is that flowers are borne on newly emerging lateral shoots, irrespective of time of the year (Rathore and Singh, 1974), due to which it is suitable for pruning for various purposes. As a result, the occurrence of bloom and fruiting in the course of the year may be irregular or season depending on how the environment affects 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 (Thakre et. al., 2016). Consequence, changes in seasonal fluctuations of reserves can appear as well (Clair et. al., 1999). In this way, pruning helps in both ways, firstly to regulate crop (Kindo, 2005) and secondly to manage high density (Kaur and Dhaliwal, 2001). Serrano et. al., (2008) also reported that the light pruning increased the number of productive branches and number of fruits per branch of Guava cv. Paluma. Pruning the current season’s growth of spring flush to avoid the rainy season crop was advocated by Singh (1980) and similar experiment was also conducted by Tiwari and Lai (1984). The pruning of 25-50% shoots on 20 April, 10 May or 30 May was found to escape flowering in rainy season and encouraged winter season flowering of Sardar guava by Dhaliwal et. al. (1998).

Maximum flower number, fruit set, fruit retention and yield (109.68 kg/ tree) with 30 cm pruning in winter crop of guava was observed by Bajpai et. al. (1973). Whereas, Sahay and Kumar (2002) reported that pruning of half of the current shoots resulted in highest crop yield during the winter crop (36.20 kg/plant), total cost (Rs. 13 per plant) and net profit (Rs. 340.62 per plant) in guava. Similarly, Dhaliwal et. al. (2000) studied on 5 intensities levels of pruning (control, 25, 50, 75 and 100 %) on 6 dates (From 20 February to 30 May at 20 days intervals) in guava cv. ‘Sardar’ and found that percent fruit set, fruit weight fruit retentions, TSS, ascorbic acid increased in winter crop with increasing pruning intensities and maximum fruit number was at 50 percent intensity while minimum was at 100 percent. Agnihotri et. al., (2016) found that pruning with 75% intensity at 50% bloom stage in the month of April showed significantly superior with respect to number of newly emerged shoots and per cent increase in shoot growth after 60 days of pruning in guava. Salah (2005) observed the highest bud emergence of guava by using severe and moderate pruning.

Shoot growth was reduced in May and June pruned trees where as total yield during winter season increased significantly in May and June pruned trees in both the cultivars of guava (Allahabad Safeda and Sardar). Similar results were obtained by Singh et. al., (2001) with pruning in February and March compared with pruning from April to June enhanced the number of shoots and flower percentage. Jadhao et. al., (1998) revealed that pruning up to 60 cm from tip on April, 25 resulted in the most vigorous growth and highest fruit yield in winter season compared to other dates of pruning (25 March, 25 May, 25 June) and pruning intensities (30 cm of the shoot tip or no pruning) in guava cv. ‘Sardar’. Likewise, Mishra and Pathak (1998) reported that 50 percent pruning in May produced highest yield (25.8 kg/tree) than unpruned (7.6 kg / tree) in winter crop of guava

Table 1: Nutritional Value of guava fruit in 100 g, edible portion (Kafle et. al., 2018).

| Nutrient           | Value          |
|--------------------|----------------|
| Energy             | 285.285 KJ (68 kcal) |
| Carbohydrates      | 14.32 g        |
| Sugars             | 8.92 g         |
| Dietary fiber      | 5.4 g          |
| Fat                | 0.95 g         |
| Protein            | 2.55 g         |
| Vitamin A equiv.   | 31 µg          |
| beta-Carotene      | 374 µg         |
| Thiamine (B1)      | 0.067 mg       |
| Riboflavin (B2)    | 0.04 mg        |
| Niacin (B3)        | 1.084 mg       |
| Pantothenic acid   | 0.451 mg       |
| Vitamin B6         | 0.11 mg        |
| Folate (B9)        | 49 µg          |
| Vitamin C          | 228.3 mg       |
| Vitamin K          | 2.2 µg         |
| Iron               | 0.26 mg        |
| Magnesium          | 22 mg          |
| Manganese          | 0.15 mg        |
| Phosphorus         | 40 mg          |
| Potassium          | 417 mg         |
| Sodium             | 2 mg           |
| Zinc               | 0.23 mg        |
| Lycopene           | 5204 µg        |

Table 2: Flowering and fruiting season in guava.

| Bahar              | Month         | Water stress   | Flowering       | Fruiting     |
|--------------------|---------------|----------------|-----------------|--------------|
| Ambe bahar (February) | December-January | February-March | July-August     |
| Mrig bahar (June)   | August-September | October-November | March-April    |
| Hasta bahar(October) | 3rd week of April | June-July      | November-December |
Crop regulation by water stress

In northern plains, Mrig-bahar is preferred over ambe and hast-bahars, therefore, it becomes necessary to regulate flowering, so that Mrig-bahar can produce heavy flowering and fruits are available in winter. The practices followed for taking Mrig-bahar are: Restricting irrigation water. The trees should not be given irrigation from February to mid of May. Doing so, the tree sheds its leaves during hot season (April-May) and goes to rest. During this rest period, trees can conserve food material in its branches (Pedapati, 2015). In guava the operations of withholding water, exposing feeding roots and pruning fibrous roots to force blossom in the desired season are practiced in Mumbai and Deccan (Singh et al., 2018). Stress was exerted on trees by withholding water from January to June, and the non-stressed control trees were watered at an interval of 10-15 days, depending on the evaporation. The abscission of flowers was noticed when relative water content reached 60.20% in ‘Alallahabad Safeda’ and 53.40% in ‘Sardar’ guava.

A trend was also noticed in the quantity of leaf proline according to the degree of water stress (Singh et al., 1997).

In certain parts of Maharashtra, roots are exposed and minute roots are cut away and irrigation is withheld so as to allow the leaves to shed. Then, the basins are covered with the manures and irrigated copiously (Kumar, 2010). Similarly, Singh (1983) recommended withholding of water for those areas of the western India where soils were lighter. However for heavier soils suggested root pruning in addition to the withholding of water during December or January. In guava the operations of withholding water, exposing feeding roots and pruning fibrous roots to force blossom in the desired season are practiced.

Root exposure and root pruning

Roots of the plant are exposed to sun by removing up to 7-10 cm soil around 40-60 cm radius of tree trunk. The water is withheld for a month or two before flowering. As a result of water stress, leaves show wilting and fall on the ground. Before one month of commence of flowering of desired bahar, roots are again covered with a mixture of soil and FYM and irrigated immediately. Subsequent irrigations are given at suitable intervals. Consequently, plants give new vegetative growth, profuse flowering and fruiting. However, in light sandy and shallow soils, exposure of roots should not be practiced and mere withholding of water for 2-3 weeks is sufficient for wilting and debilitation of trees. It depends upon the choice of the grower as to which of the three bahar is to be taken to get maximum profit. As the availability of water is a problem in central India during April – May, the farmers prefer Mrig bahar (June) so that the plants are forced to rest in April – May and no water is required during the period. Cheema et al., (1954) reported that root exposure and root pruning can be used to suppress the rainy season crop so as to get a good winter crop in guava. Radha and Mathew (2007) suggested that upper soil surrounding trunk, about 90 to 120 cm diameter is removed to expose roots. After about 3-4 weeks, exposed roots are covered with soil, followed by manuring and irrigation.

Root pruning is the practice of removing a portion of a tree’s root system or severing the roots of a tree, all the way around the tree’s circumference at the drip line. Root pruning is very seldom recommended or adopted in practice except at the time trees are lifted from a nursery and planted in the permanent site. Hussein (2006) utilized four pruning techniques in guava namely, removal of 20% and 40% of the total leaves, root pruning and the combination of removal of 30% of leaves plus root pruning and revealed that all pruning techniques resulted in significantly greater increases in plant height and stem diameter than the control. No clear pattern was noted regarding other growth parameters in terms of number of leaves and relative growth rate; however, root pruning resulted in greater values than the rest of the treatments. The roots are exposed and minute roots are cut away and irrigation is withheld so as to allow the leaves to shed in guava (Kumar, 2010). Root pruning however has a harmful effect on the longevity of trees (Sharma, 2006). In certain parts of Maharashtra, root pruning is practiced to produce heavy yield. Root pruning is not recommended in Uttar Pradesh as it imposes moisture stress resulting in leaf drop and cessation of growth of crop during period of unwanted Bahar (Singh, 2013).

Bending of guava shoots for crop regulation

Shoot bending is one of the ways to produce better quality fruits in the off-season of guava (Sarker et al., 2005). In case of bending of branch wood tension of branch is increased and phloem formation decreased. As a result photosynthetic product pass slowly from the shoots of bent branch to the other parts, maintaining increased C: N ratio and induce more flowering and fruit set. The upright branch produces fewer flowers and fruits than the bent branch (Ito et al., 1999). Bending induces profuse flowering and fruiting and fetches greater returns (Ghosh and Sukul, 2003; Sarker et al., 2005).

Shoot bending also improved productivity of guava in different varieties at Bangladesh (Mamun et al., 2012). Nandi et al., 2017 observed that bending in guava cv. Khaja in the month of October is most effective in increasing flowering shoot (32.33/branch) and fruit yield (63.66 kg/plant) followed by bending in June. Samant et al., (2016) has also shown the positive effect of shoot bending in guava. Mamum et al. (2012) found highest number of flower set per plant when shoot bending treatment was given during on-season (312.33) and in off-season it was (111.33). Most of the growers of West Bengal prefer winter season crop and regulate flowering by bending the shoots in the month of August-September (Mitra et al.2008). This practice is very much dependent on training of guava branches. On the basis of calculation of expected flowering the branches of guava plants are bent down about 45-60 days before the expected date of flowering and to produce fruits in the off season. First time bending of branches of guava plant should be employed at the age of 2 years of plant. Shoot bending

cv. ‘Sardar’. Singh and Bai (2006) stated that pruning with (10 and 20 cm) and use of growth regulators (paclorbutrazol and ethephon at 500 and 1000 ppm) on guava cv. Allahabad Safeda trees during rainy season show best physical characters like fruit weight at 20 cm level of pruning, whereas, fruit quality (chemical characters) were noted better at 10 cm level of pruning.
increased the fruits set per plant during off-season is also reported by Sarker and Ghosh (2006). Similarly, shoot bending increased the fruit yield per plant and quality fruit during off-season (Sarker et al., 2005). Bending induces profuse flowering and fruiting, as well as fetches greater returns and regulates flowering (Ghosh, 2003). The shoot bending treatment result the highest number of fruits set per plant both on and off season (246.86) and (67.33), respectively.

**Crop regulation by use of chemical**

In order to avoid heavy crop load during rainy season use of chemicals is an important tool for crop regulation to get quantity and quality yield (Singh et al., 2001). Growth regulators has been found very effective in thinning of flowers and manipulating the cropping season NAA, 2,4-D carbasyl and ethephon were found successful in reducing the rainy season and increasing the winter crop under different agro-climatic conditions (Chundawat et al., 1975). Manual deblossoming of rainy season flowers at small scale, kitchen garden and early age of the plant is very effective, but at large commercial plantation it is not in practice which is very cumbersome, laborious and uneconomic. Crop regulation through chemical spray is an easy means of regulating the crop. Different chemicals caused deblossoming in rainy season crop and subsequently increased the winter season crop. Singh et al., (2002) observed that crop regulation in guava with the help of single spray of 25% urea and double sprays of 10% urea in Sardar and Allahabad Safeda, respectively at bloom stage (April-May) has been found economically efficient for quality production. These treatments did not affect the tree adversely, the fruit quality was better as the fruiting was mainly concentrated in winter. It has also been observed that urea spray suppressed shoot growth, producing severe leaf fall followed by initiation of new shoot on which flower buds are formed for following winter season. Kaur (1997) found maximum abscission of flowers by the spray of 0.5 per cent potassium oxide followed by 20 per cent urea. Maximum deblossoming has been observed with 20 per cent urea spray in guava (Dwivedi et al., 1990 and Bariana, 1988), Whereas Singh et al., (1994) and Choudhary et al., (1997b) found 15 per cent urea most effective in deblossoming the rainy season guava crop. Rathore (1975) reported 96 per cent deblossoming with 100 ppm NAA in guava. Whereas, Chundawat et al., (1975) noted 24, 51 and 82 per cent deblossoming with 100, 200 and 400 ppm NAA spray, respectively. Complete deblossoming has been found by Pandey et al., (1980) with 400 ppm of NAA and Singh and Singh (1975) obtained complete deblossoming with 2000 ppm MH in guava. Singh et al., (2000) advocated that spraying of 10 percent urea gave significantly higher yield (100 kg tree⁻¹) in ‘Allahabad Safeda’ during winter season. However, two sprays of 10 percent urea and 15 percent urea at 10 days intervals during in summer season was economically feasible for crop regulation of ‘Allahabad Safeda’ and ‘Sardar’ guava, respectively. Similar observations were also made by Rajput et al. (1986) and found that Spray of urea (12, 15 and 20%) in guava crop resulted in no flowering and fruiting in summer season. Further, it result maximization in fruit number and fruit yield. However, fruit size was reduced in winter season with an increase in urea concentration.

During different cropping season, maximum length, width and weight of fruits were found in winter season followed by spring and rainy season. Spray of NAA (250 ppm) on 10 year old guava trees cv. Allahabad Safeda caused maximum defoliation in rainy season flowering and produced maximum yield and quality fruits during winter Dubey et al., (2002). Similar findings were reported by Choudhary et al., (1997a) and Das et al., (2007). Kundu and Mitra (1997) noted that NAA 100 ppm and 2,4-D 100 ppm markedly increased the average size, weight of fruit as well as pulp content on 11 year old guava cv. L- 49. While, Singh et al., (1993) studied on 5 year old Allahabad Safeda guava and reported that among the chemicals used for crop regulation, NAA 50 and 75 ppm gave best results followed by NAA 200 and 100 ppm. Yadav et al., (2001) recorded that spray of NAA 60 ppm in 15 year old guava tree cv. Sardar, produced maximum fruit yield, weight and ascorbic acid in the winter season crop. Kumar and Hooda (1977) reported on 15 year old guava trees cv. Allahabad Safeda that among the chemicals NAA at 50 ppm followed by 2, 4-D at 30 ppm gave better results. Correspondingly, Agnihotri et al., (2013) found increased canopy spread, volume of fruit (185.38 ml), pulp thickness, pulp weight (175.57g), pulp per cent (96.6), diameter of fruit (7.34 cm), average fruit weight (181.71g) and reduced seed per cent and seed pulp ratio with foliar spray of 60 ppm 2,4-D which ultimately increased the yield per tree. Kaur and Kaur (2017) concluded from their study that 2,4-D 50 ppm was found to be the most effective treatment in enhancing the fruit yield and improving the fruit quality as compared to other treatments of NAA and urea in guava cv. Allahabad Safeda. Lal and Das (2017) recorded GA₃ (50 ppm) with increased yield and quality of Allahabad Safeda guava in Assam condition.

**Crop regulation for economic benefits**

In India, there is an increasing demand from consumers and marketers for quality guava fruits. Fruits of the two most popular cultivars of guava grown in India, ‘Allahabad Safeda’ and ‘Sardar’ are intrinsically poor in quality during rainy season (Singh et al., 2002). On the contrary, winter season crop bears quality fruits which fetch high monetary returns (Singh et al., 2000). Obviously, regulation of crop will help to overcome such problems to a great extent by judicious flower thinning during summers. Understanding of crop regulation will help to optimize harvest time which reduce surplus in the market, to obtain higher price of the produce, to avoid spoilage due to excessive production at a particular time, to provide employment throughout the year and balance the trade and to reduce imports. Gurjar et al., (2018) obtained maximum and statistically higher yield (119.73 q/ha.), gross return (Rs 32925 per hectare) and net return (Rs 230529 per hectare) under application of 800 PPM NAA plant growth regulator. Highest cost benefit ratio (1:3.33) was also recorded under the treatment of 800 ppm of NAA which was most economic and feasible practice of crop regulation in guava fruit crop. Similarly Singh et al., (2000) reported significantly higher yield (100 kg/tree) in ‘Allahabad Safeda’ with spray of 10 % urea during winter season, while,
in ‘Sardar’ guava highest yield (103.98 kg/tree) was recorded with the spray of 1800 ppm ethephon during the same season which was closely followed by 20 and 15 % urea (100.25 and 96.38 kg/tree, respectively). The control trees of ‘Sardar’ and ‘Allahabad Safeda’ could give only 29.15 and 26.14 kg/tree respectively during this season. However, double spray of 15 % urea on ‘Sardar’ resulted into highest net future value, i.e., Rs 849/tree, over the entire period of experimentation, which was Rs 223 more than the control. Highest net future value in ‘Allahabad Safeda’, i.e., Rs 802/ tree, was obtained with double spray of 10 % urea over the entire period of experimentation, which was Rs 309 more than the control. Maji et al., (2015) found highest benefit: cost ratio (7.84:1) by summer deblossoming with spray of NAD@ 60 ppm. Thakre (2016) also noticed that one leaf pair pruning of fruited shoots only (OLPF) in guava cv. Pant Prabhat was more profitable among other treatments by recording cost: benefit ratio of 1:2.96. This treatment also recorded the highest return distributed in rainy as well as in winter season.

CONCLUSION

Guava (Psidium guajava L.) is one of the most popular tropical and subtropical fruit crops grown in India owing to its several health promoting properties and value-addition avenues. Here are three distinct flowering seasons viz., spring (Ambe Bahar), rainy (Mrig Bahar) and autumn (Hasta Bahar) with the corresponding harvesting periods during the rainy, winter and spring seasons in guava. The rainy season crop of guava is rough, insipid, poor in quality, less nutritive and is attacked by several insect pests and diseases. The winter season fruits are superior in quality, free from diseases and pests and fetch more prices in the market. Therefore, the natural flowering and fruiting behaviour of guava are needed to be regulated, towards the production of heavy crop of Sardar guava. M sc Thesis submitted to Punjab Agric Univ, Ludhiana.

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ISSN: 0976-0539 (Online), 0253-1496 (Print), Naas Rating: 4.37