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Effect of Pruning and Fertigation on Plant Biometric Characters in Guava (*Psidium guajava* L.) – A Review

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Abstract

Guava (*Psidium guajava* L.), is one of the most important fruit crops cultivated widely in tropical region of the world and considered as 'poor man's apple' or 'the apple of tropics' due to its low cost of production and high nutritional value. Pruning is one of the most ancient horticultural practices which regulate the tree size and shape to achieve a desired architecture of the canopy and also to reduce the vegetative growth by removing unproductive branches of the tree. Guava is an evergreen tropical fruit crop and rarely pruned in our country to regulate the canopy for better yield and quality of fruits despite that guava responds to pruning. Fertigation (application of fertilizer solution with drip irrigation) has the potential for the right combination of water and nutrient which make it available at the root zone, satisfying the plant requirements. These inputs are the key factors for high yield and quality. Fertigation saves fertilizer as it permits applied fertilizer in required quantities at a time matching with the plants nutrient requirement. Besides, it is considered as eco-friendly which avoids leaching (Sharma *et al.,* 2012) and also saves atmospheric pollution.

1. Introduction

Guava has wide adaptability to varying condition of soil and climate. This fruit crop has immense potential to increase the productivity and sustainable yield. Being the tropical fruit crop, the limited water resource is a constraint for increasing the area under guava cultivation. Terminal portion of the shoots up to 20 or 30 cmlength should be pruned between 20th to 30th April. Always avoid severe pruning in guava. Pruning the current season's growth of spring flush to avoid the rainy season crop was advocated by Sharma *et al*. (1980). Pruning current season's growth of spring flush to avoid rainy season crop has been advocated in northern parts of the country (Tiwari and Lal, 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 (Dhaliwal *et al*., 1998).

Fertigation enables adequate supply of water and nutrients with precise manner and uniform distribution to meet the crop nutrient demand. Further, fertigation ensures substantial savings in fertilizer and water usage which reduce the leaching losses (Kumar *et al.,* 2007). Frequent application of water and optimum split application of fertilizers in the form of fertigation improve the quality and quantity of crop yield than the conventional practice. Sharma *et al.* (2011) obtained the higher guava yield through fertigation than basin irrigation which also checks the seepage production and evaporation losses water. In this connection, there is a need to adopt the precise nutrient application coupled with canopy management strategies for higher yield and quality of guava in Tamil Nadu.

1.1. Effect of pruning and fertigation on plant biometric characters

1.1.1. Fresh weight of pruned branches

Shivashankar (1995) reported that application of 100 per cent recommended dose of fertilizer as water soluble fertilizers increased the fresh weight of leaves (4.60 g), leaf area (153.60 cm^2), specific leaf weight (15.90 mg per cm^2) and dry matter content (47.26 %) of leaves in sapota. Cripps and Allan (1997) studied the effects of N, P and K on 'Honey Gold' papaya and also found that high levels of 250 kg N, 200 kg P and 340 kg K per hectare resulted in larger plant fresh mass.

1.1.2. Plant height

Dalal *et al.* (2000) reported that in guava cv. Sardar, the highest plant height was recorded in pruned plants than control. Dhomane *et al.* (2012) informed that application of 75 % nitrogen through urea + 25 % N through FYM increased the tree height in guava cv. Sardar. Teotia *et al*. (1969) stated that in guava, the maximum height was noticed with increasing dose of nitrogen. Singh and Srivastava (1978) recommended that 60 g N+ 40 g P + 40 g

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K per plant per year to guava for better vegetative growth. Mitra *et al*. (1985) reported that 900 g N, 600 g P and 600 g K per tree per year increased the plant height in guava cv. L-49 which was applied in two equal split doses *i.e.,* January and August.

Walling and Sanyal (1995) advocated that the split dose of N, P, K (375 g N + 300 g P + 100 g K) in the month of February and August were found better for the plant height in guava cv. Allahabad Safeda. Kumar *et al*. (1996) reported that application of 100 g N per plant increased the plant height in guava cv. Allahabad Safeda. An experiment was carried out to study the influence of N, P and K in pomegranate cv. Bassein Seedless and the result indicated that the plant height was increased significantly with the application of N 500 g per plant per year (Prasanna kumar and Dhandhar, 1996). Shirgure *et al.* (1997) reported that the increase in plant height, girth and canopy volume was maximum with 100 % N fertigation followed by 80 % N fertigation in acid lime. The plant height of sapota was maximum with 80 % and 100 % RDF as water soluble fertilizers through fertigation than 100 % normal fertilizers with irrigation or basin irrigation (Shivashankar *et al.,* 1998).

Basu *et al.* (2007) reported that in guava cv. Lucknow – 49, the highest plant height (3.7 m) was recorded in March pruning. Rao and Subaramanyan (2009) found that the 50 % recommended dose of nitrogen at fortnight intervals enhanced the plant height in pomegranate cv. Mridula. Virendra kumar *et al*. (2010) reported that the plant height was increased in guava cv. Sardar when applied with 800:600:600 g N, P, K per tree per year. Kumar and Rattanpal (2010) reported that the pruning treatment by 50 % removal of vegetative growth increased the tree height (5.3 m) in guava cv. Sardar. Under different fertigation levels, maximum plant height was recorded with application of 60, 30, 30 g N, P, K per tree per year as water soluble fertilizers in guava cv. Shweta (Ramniwas *et al.,* 2012).

1.1.3. Number of new shoots emerged from pruned branches

The fruit production is bound to increase with increase in the number of new shoots produced since the new shoots are the potent fruit bearing organ in guava. In general, pruning can influence an early emergence of more new shoots. Dasarathy (1951) at Kodur observed an earlier activation of flowering buds in guava as a result of cutting 50 per cent length of shoots. Aravindakshan (1963) also reported an early production of lateral shoots by pruning in guava. Tipping off previous season's leader shoots by 10 -12 cm in guava resulted in an increased number of leaders per pruned leader shoot as compared to the unpruned control (Sundararajan and Muthuswamy, 1964).

Dhaliwal *et al*. (1998) reported that pruning of current season growth (leaving 100 cm from the place of origin) had the earlier shoot emergency in guava cv. Sardar. Singh *et al*. (2001) informed that light pruning (removal of 10 cm tip) increased the number of new shoots in guava cvs. Allahabad Safeda and Sardar. Jadhav *et al*. (2002) reported that the severely pruned shoot induced the earliest shoot emergence compared to unpruned tree in guava cv. Allahabad Safeda. In guava cv. Lucknow-49, the highest shoot length with open centre system of training was obtained by Kusumakumari and Sriharibabu (2003). Pratibha and Lal (2012) revealed that the one leaf per shoot pruning had significantly influenced the emergence of new shoots in guava cv. Sardar. Walling and Sanyal (1995) advocated that split application of N, P, K (375 g N + 300 g P + 100 g K) in the month of February and August were found to be better for shoot growth in guava cv. Allahabad Safeda. Joshi and Lal (2012) reported that one leaf pair pruning and application of N, P, K (75 g N, 65 g P, and 50 g K) increased the number of new shoots in guava cv. Pant Prabhat.

1.1.4. Shoot length

Jadhav *et al*. (2002) reported that severely pruned shoot had exhibited maximum shoot length compared to unpruned tree in guava cv. Allahabad Safeda. The mango trees when pruned uniformly by decapitation of shoots to 10 cm back from the tip produced many laterals. This pruning had resulted in one lateral along with flushes (one, two, three and four flushes) which showed the highest shoot length than other laterals in mango cv. Baneshan (Suresh Kumar *et al.,* 2003). Metha *et al*. (2012) reported that shoot length was increased with 50 per cent pruning in guava cv. Sardar compared to control.

Mitra *et al*. (1985) reported that application of 900 g N, 600 g P and 600 g K per tree per year increased the shoot length in guava cv. Sardar. Chauhan and Chandel (2008) studied that 75 per cent recommended dose of NPK (600 g N: 200 g P: 1000 g K per tree per year) recorded the highest shoot growth in kiwi fruits. Singh *et al.* (2009) observed the maximum shoot height in I_2F_1 (drip irrigation at 0.8 'V' level with mulch + 100 % dose of fertilizers through fertigation) and least shoot length in the treatment I_4F_2 (drip irrigation at 0.6 'V' level without mulch + 75 % dose of fertilizers through fertigation) of young Dashehari mango. Dhomane *et al.* (2012) reported that application of 75% nitrogen through urea + 25 % N through FYM had increased shoot length in guava cv. Sardar.

1.1.5. Canopy spread (m)

Pomegranate trees were pruned to leave a single stem, two, three and four stems at ground level. The treatment with four stems from base produced the greatest canopy spread in pomegranate (Balasubramaniyan *et al*., 1997). Mitra *et al*. (1985) reported that application of 900 g N, 600 g P and 600 g K per tree per year in two equal split doses *i.e.,* January and August increased the plant spread in guava cv. Lucknow - 49. Wagh and Mahajan (1985) noticed better vegetative growth of guava cv. Sardar from the trees receiving NPK at 600 g: 300 g: 300 g + 25 kg farm yard manure in Maharshtra. Singh (1990) noted that the maximum canopy spread of guava cv. Sardar with 540 g N + 360 g P + 360 g K per tree per year. Natale *et al*. (1994) found that 210 g N + 240 g P + 240

g K per plant in four split doses were more effective for vegetative growth of guava. Shivashankar (1995) reported that application of 100 per cent recommended dose of fertilizers as water soluble fertilizers had increased the plant spread in sapota.

Walling and Sanyal (1995) opined that application of 375 g N + 300 g P + 100 g K as split doses in the month of February and August were better for tree spread in guava cv. Allahabad Safeda. Prasittikheb *et al*. (2000) stated that the mango cv. Khiew Sowey, the leaf area per square meter of canopy surface area was maximum under fertigation with 600 N: 250 P: 750 K g per plant per year. In pomegranate cv. Mridula, Ganpat (2001) reported that 75 per cent recommended dose of fertilizers through fertigation recorded the higher plant spread (2.55 m^2). Virendra kumar *et al*. (2010) reported that the increased plant spread was noticed when applied with 800:600:600 g NPK per tree per year in guava cv. Sardar. Pilania *et al*. (2010) reported that pruning 25 % of previous season growth resulted in maximum canopy spread in guava cv. Lalit. Kumar and Rattanpal (2010) informed that the pruning by 50 % removal of vegetative growth increased the tree spread (6.5 m^3) in guava cv. Sardar.

Dhomane *et al.* (2012) reported that application of 75 % nitrogen through urea + 25 % N through FYM increased the tree spread in guava cv. Sardar. Joshi and Lal (2012) reported that the one leaf pair pruning and application of N, P, K (75 g N, 65 g P, 50 g K) had increased the highest plant spread in guava cv. Pant Prabhat. Ramniwas *et al.* (2012) reported that maximum plant spread was recorded in guava cv. Shweta when 60 g N, 30 g P, 30 g K applied as water soluble fertilizers.

1.1.6. Days taken for first flowering

The results regarding the influence of pruning at the time of flower emergence and duration of flowering have been quite confusing and contradictory in various fruit crops. Tipping off previous season's leader shoots in guava hastened the flower production by about a fortnight. Moreover, there was a distinct shortening of total period from pruning to complete flowering, the difference being 39-43 days over the unpruned (Aravindakshan, 1963). Sundararajan and Muthuswamy (1964) observed that in guava, the pruned trees not only induced the flowering but also noticed early flowering about 23-28 days over the control. On the contrary, pruning in ber cvs. Pewandi and Kadaka resulted in delayed flowering which was proportional to the severity of pruning (Lal and Prasad 1980)

Lotter and Lotter (1990) observed that the number of inflorescence were significantly lesser than that in intact shoots of all the spring pruned guava shoots. Similarly, adverse effect of pruning on flower production in guava was observed by Sheikh and Hulmani (1996). Curti (1996) reported that six year old *citrus latifolia* trees to shoot pruning (removal of 10 cm from tips of shoots) was encouraging for flower production in autumn. Mishra and Pathak (1998) observed that the increased number of flowers per plant (13.03 number of flowers per pruned shoot) with the pruning of 50 cm from the tips of shoot during the month of March in guava cv. Sardar. Anez (1998) obtained the highest number of flowers and flowers per shoot with light or moderate pruning in 3-year-old guava tree (clones Mara 6 and Mara 8) at Venezuela.

Nanthakumar *et al*. (1999) reported that the higher numbers of flowers per branch under medium pruning while the lower number of flowers per branch were recorded under control (unpruned trees) in ber. Dhaliwal and Kaur (2003) reported that an early flower bud emergence (118.3 days) and flowering shoots (36.89 days) was noticed with the pruning intensity of 10 cm during the month of April in guava cv. Sardar. Singh (2012) mentioned that a severe pruning level of 8-node and 10 node has recorded the early flowering both in rainy and winter seasons in guava cv. Lucknow - 49. Pratibha and Lal (2013) informed that maximum number of flower bud emergence was found under treatment combinations of one leaf pair shoot pruning with square system of planting in guava. Dhomane *et al.* (2012) reported that application of 75 % nitrogen through urea + 25 % N through FYM increased the number of flowers in guava cv. Sardar. Ramniwas *et al.* (2012) reported that better flowering was recorded in guava cv. Shweta when 60 g N, 30 g P, 30 g K applied as water soluble fertilizers.

2.2. Effect of pruning and fertigation on physiological parameters

2.2.1. Chlorophyll content

Schaffer and Gaye (1989) found that the total chlorophyll content was the highest in pruned trees during November in mango cv. Tommy Atkins. Dhakar *et al.* (2010) studied the effect of fertigation in pomegranate cv. Bhagwa and concluded that total chlorophyll content was found to be maximum in 150 % RDF (100: 250: 500 g of NPK per plant) which was on par with 125 % RDF and minimum in 75 % RDF. Ramniwas *et al.* (2012) reported that maximum chlorophyll content was recorded in guava cv. Shweta when 60 g N, 30 g P, 30 g K applied as water soluble fertilizers

2.2.2. Light transmission ratio

Pruning influences photosynthesis indirectly by improving the interception of light and its distribution within the tree canopy by avoiding self-shading. One of the main purpose of pruning is to facilitate light penetration into bearing area of the tree (Jackson and Palmer, 1980). Pruning practices in evergreen orchards are primarily based on maximum light absorption which leads to more photosynthesis. Pruning altered the percentage of light interception by the orchard canopy (Whiley and Scaffer, 1997). Pratap *et al*. (2003) noted that light penetrance was the highest in severely pruned trees (30 cm from apex) in mango cv. Amrapali.

In sapota cv. PKM (Sa) 4, light interception was higher with moderately pruned trees (pruning the length of secondaries to retain only half of its length) and was lower in unpruned

trees (Sathiya, 2005). Singh and Singh (2007) observed that light penetration was greater in pruned trees compared to non-pruned trees in guava cvs. Allahabad Safeda and Sardar. Jannoyer and Lauri (2009) observed that the removal of 75 per cent vegetative shoots (10-20 cm, leaves at the 'soft green' stage) on the tree, improved light penetration within the canopy.

2.2.3. Total carbohydrate

Wolstenholme and Whiley (1995) indicated that by practicing renewal pruning, first it removes carbon starved, exhausted fruiting shoots which will not fruit in the current season. Secondly, the old leaves are replaced with young and active leaves that make a better chance to build up carbohydrate reserves in mango. Flushing is important because new mango leaves are efficient producers of carbohydrates, the tree building materials and source of energy (Oosthuyse, 1995). Choseong *et al.* (2011) reported that the application of high N through fertigation (40 g per tree) had increased the carbohydrate compared to control in persimmon cv. Fuyu.

2.2.4. C: N ratio

Saidha (1980) observed that pruning influenced positively the dry matter content and reached the maximum by October – November, so that the C: N ratio was the highest during November -December in mango cvs. Neelum, Bangalora, Mulgoa and Peter. In sapota cv. PKM (Sa) 4, C: N ratio was higher with moderately pruned trees (pruning the length of secondaries to retain only half of its length) and was lower in control (Sathiya, 2005). Ramniwas *et al.* (2012) reported that maximum carbon assimilation rate (5.09 µ mol m^{-2} s^{-1}) was recorded in guava cv. Shweta when 60 g N, 30 g P, 30 g K applied as water soluble fertilizers.

2.3. Leaf nutrient content

2.3.1. Nitrogen content

Wagh and Mahajan (1988) reported that soil application of 900 g N, 300 g P and 300 g K per tree per year in guava cv. Lucknow - 49 showed higher level of leaf nitrogen and phosphorus content. Tassarkoj *et al.* (1989) observed that the application of different dose of nitrogenous fertilizer at 200 g, 400 g and 600 g N per tree in the first week of May for rainy season and the first week of July for winter season have increased the leaf nitrogen content in guava cv. Sardar.

Shirgure *et al.* (1997) reported that increase in the leaf nitrogen content was observed in 80 % N applied through fertigation system in acid lime. Ram *et al*. (1999) reported that the application of urea (600 g), SSP (200 g) and MOP (200 g) had increased the leaf nitrogen content in guava cv. Sardar. Torres *et al.* (2004) reported that application of nitrogen at the rate of 23 mg L^{-1} significantly increased the leaf N content (14.9 g per kg, dry weight) than control (13.4 g per kg dry weight) in mango cv. Sensation.

Tejinerkaur and Chahil (2006) revealed that the application of NPK (400 g: 200 g: 100 g) registered the maximum leaf nitrogen content in guava cv. Sardar. Singh *et al.* (2006) revealed that the application of 100 % RDF (625: 250: 250 g of NPK per plant) increased the leaf nitrogen content compared to control in mango cv. Amrapali. Chauhan and Chandel (2008) studied that 75 % recommended dose of NPK (600 g N: 200 g P: 1000 g K per tree) had significantly improved the leaf nitrogen contents in kiwi cv. Allison.

2.3.2. Phosphorous content

Singh and Singh (1973) reported that the highest phosphorus level was registered in pruned shoots as compared to unpruned shoots during the flower bud formation as well as in fruit development in mango. Tassarkoj *et al.* (1989) revealed that the higher phosphorus application (600 g) per tree per year as split doses during the month of May for rainy season and July for winter season increased the leaf phosphorus content for the rainy and winter seasons in guava cv. Sardar.

Ram *et al*. (1999) reported that application of urea (600 g), SSP (200 g) and MOP (200 g) had increased the leaf phosphorus content in guava cv. Sardar. Tejinerkaur and Chahil (2006) revealed that the application of NPK (400 g: 200 g: 100 g) maximized the leaf phosphorous content in guava cv. Sardar. Singh *et al.* (2006) revealed that the application of 100 % RDF (625: 250: 250 g of NPK per plant) increased the leaf phosphorous content compared to control in mango. Chauhan and Chandel (2008) reported that 75 % RDF (600 g N: 200 g P: 1000 g K per tree) had significantly improved the leaf phosphorus contents in kiwi cv. Allison.

2.3.3. Potassium content

Tassarkoj *et al.* (1989) revealed that NPK application (150: 300: 450 g per plant per year) increased the leaf potassium content in guava cv. Sardar. Ram *et al*. (1999) reported that the application of urea (600 g), SSP (200 g) and MOP (200 g) increased the leaf potassium content in guava cv. Sardar. Zhou *et al.* (2002) reported that the application of 320 g K per plant increased the leaf K content in mango.

Tejinerkaur and Chahil (2006) revealed that the application of the NPK (400 g: 200 g: 100 g) maximized the leaf potassium content in guava cv. Sardar. Singh *et al.* (2006) informed that the application of 100 % RDF (625: 250: 250 g of NPK per plant) increased the leaf potassium content compared to control in mango. Chauhan and Chandel (2008) reported that 75 % RDF (600 g N: 200 g P: 1000 g K per tree) had significantly improved the leaf potassium content in kiwi cv. Allison.

2.2. Soil available nutritional status

The fertigation frequency and dose may also affect the nutrient levels in the soil. A direct relationship was found between nitrate concentration in a sandy loam soil and the rate of N applied in citrus (Dasberg *et al.,* 1988). Singh (1990) reported that the application of N, P and K fertilizers had no significant effect on available N, P and K contents in the soil of guava orchard. Sharma *et al.* (1992) reported that recommended dose of N, P, K and FYM (6.0 t per ha) increased

the water holding capacity and improved the phsico-chemical properties of the soil.

Pan *et al.* (2011) observed that fertigation increased the concentration of available P by 108 per cent and decreased the P absorption index by 31 per cent in the 0-8 cm surface soil of banana roots. Fertigation enhanced the transformation of different P fractions, increased the concentrations of aluminum-bound P (Al-P), iron-bound P (Fe-P) and occluded-P (O-P), and decreased the pH value by 0.3 units. Fertigation also increased the microbial biomass and root activity by 25.5 - 67.8 in banana seedlings.

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