ROLE OF PLANT GROWTH REGULATOR'S IN GUAVA (PSIDIUM GUAJAVA L.) - A REVIEW

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ABSTRACT

Plant hormone play a key role in guava production by influencing directly or indirectly various plant processes like germination, rooting, growth and productivity of guava. These also can influence size, appearance and quality parameters of fruits by indirectly affecting the crop growth and development or directly by synchronizing flowering, improving fruit-set, decreasing pre-harvest fruit drop and thinning of excessive flowers or young fruits. These may also help in maintaining the desired tree growth and shape for high density orcharding. In this review article a detailed information on research work done in India on the use of various plant growth regulators in guava production have been incorporated.

Guava (Psidium guajava L.) the apple of tropics has been cultivated in India since early 17 century, currently it has become one of the most common fruits of India. The crop covers about 1.60 lakh ha-area of the country with an annual production of 18.50 lakh tonnes (Singhal, 2003). The major guava producing states are M.P., Bihar, U.P., Karnataka, Gujarat, A.P. and Rajasthan. The existing guava production is not able to meet out the present demand of guava fruits to the increasing population of the country. It also necessitates to enhance the production potential of guava under available resources. Besides, all available high production technologies, the use of PGR's has been proved as a powerful tool to meet this demand by influencing fruit production directly or indirectly. Exogenous application of PGR's improve the seed germination (Sinha et al., 1973), rooting of cuttings (Dhua et al., 1982 b) root formation in case of stooling (Saroj and Pathak 1998), success in air layers (Chandra 1965 and Singh 1950), for good shoot formation (Jaiswal and Amin, 1987), flowering (Mohammed et al., 1984; Swart and Schipper, 1982), regulation of fruiting (Rathore, 1975; Singh and Singh, 1975; Tiwari and Lal, 1984), weight of fruits (Mitra et al., 1982; Singh 1986), vitamin ‘C’ content in fruits (Babu and Shanker, 1977; Mitra et al., 1982), the TSS (Babu and Shanker, 1977), the shelf life and reduce spoilage in storage (Saha, 1971 and Patel et al., 1993).

Thus, the plant growth regulators are useful in evolving strains of guava having dwarf growth habit for high density planting and tertiary branching for greater number of spurs and higher productivity. In addition these are useful to develop fruits with fewer and soft seeds, good aroma and better colour, higher qualitative characteristics and longer shelf life alongwith resistance to diseases.

1. Propagation

Guava is propagated by seeds or by vegetative means. The usual practice is to sow the seeds immediately after extraction. Air layering is the most popular and commercial method of vegetative propagation. In recent years various experiments have suggested that growth regulators were helpful in root stimulation. Guava seeds have a hard coat which require longer time for germination and number of seeds fail to germinate under traditional method of raising root-stock. Physical treatment and use of certain chemicals or PGR's have been found to be helpful in enhancing per cent germination of guava seeds. Treatments of guava seeds with 5,000
ppm ethephon resulted in 72 per cent germination and yielded plants with longer shoots and more laterals (Sinha et al., 1973). Rodriguez et al. (1983) obtained more than 90 per cent germination by soaking the seeds in water for 4 days followed by treating with GA₃ (1000 ppm) for 24 hours. Looney (1998) reported that some PGR's have been helpful in germination of guava seeds by increasing water uptake and exerting an effect on membrane permeability. These results indicate that use of plant growth regulator might have helped to break the embryo dormancy and induction of synthesis of d-amylase and other hydrolytic enzymes.

Hardwood, semi-hard wood and softwood stem cuttings can be used for propagation of guava, clonally under mist conditions. Stem cutting are normally difficult to root but varying degree of success has been obtained under different conditions and with certain growth regulator treatment. Singh (1950) reported 77.7 per cent success with hardwood cuttings of guava after treating with Hortomone A. Teaotia and Pandey (1961) reported that both NAA (50 ppm) and IAA (100 ppm) and 100 ppm were more effective on semi-hardwood cuttings. Blommaert (1958) recorded 75 to 90 per cent rooting with softwood cuttings under intermittent mist along with IBA treatment.

Jolicoeur (1962) reported that treatment with 0.8 per cent IBA in talc showed 44 per cent rooting under mist. Bose and Mandal (1972) reported that the cuttings of guava rooted better under mist and rooting was further enhanced by using IBA. Reddy and Majumder (1978) reported synergism of phenols and flavonoids with IBA in root regeneration of guava cuttings. Sadhu and Bose (1980) reported success in the rooting of guava cuttings by pre-soaking treatment in ethephon (50 ppm) or acetylene (100 ppm) followed by quick dip in 2,500 ppm of IBA or IAA. Treatment with P-hydroxybenzoic acid (200 ppm) in combination with IBA (5,000 ppm) recorded 93.3 per cent rooting in comparison with 60 per cent under control (Dhua et al., 1982a). Soft-wood cuttings with 2 nodes and 4 leaves rooted better than semi-hardwood cutting when treated with 2000 ppm NAA (Pereira et al., 1983). Sen et al. (1967) also reported 100 per cent rooting in the leafy cuttings of guava under intermittent mist with treatment of IBA. Debnath and Maiti (1990) also reported that IBA, NAA, IAA having 1500, 2500 and 3000 ppm concentration respectively, significantly increased the percentage of rooting. Sinha et al. (1962), Dhua et al. (1982b), Bhandari and Mukherjee (1969), Pennock and Maldonado (1963) also reported similar findings.

Air-layering is one of the most important commercial methods in practice for propagation of guava. On account of the high population of mother plants per unit area, the shoots remain juvenile for a long period, which affect the rooting ability of shoots. Use of the bio-regulators have helped in overcoming this problem. Higher success in air layers of the juvenile shoots was obtained with the application of 30 ppm each of IBA and NAA mixture (Roa and Sulikari, 1997). Although NAA has higher potential for the rooting, it is not used singly as it is toxic to the tissue, if used in higher concentration. According to Sulladmath and Kololgi, (1969) NAA had synergistic effect on the rooting when mixed with IBA formulation. Higher percentage of success in air layers by NAA treatment was recorded by Chandra (1965). In Sudan, air layering proved to be the best method of guava propagation followed by hard-wood cuttings treated with IBA (Tingwa and Abhadi, 1968). Singh and Singh (1970) obtained the best result on air layering of guava by using 2 per cent NAA. However, 3000 ppm IBA proved very
effective in the rooting of air layer of cv. L-49 (Bhujbal, 1972). All the layers treated with NAA were found to produce roots (Singh, 1950). Equal mixture of NAA and IBA at 10, 1000 ppm in talc produced the highest percentage of rooting (Anonymous, 1961). Sharma et al. (1991) reported that 10,000 ppm IBA increased success of air-layers and root quality in guava. Singh and Singh (2001) also reported that 20,000 ppm of plant growth regulators (IAA, IBA and NAA) was found optimum for better rooting. Sadhu et al. (1972), Tomar et al. (1999), Bhagat et al. (1998) and (Chandrappa and Gowda, 1998) also reported similar results.

Stool layering is one of the most relevant technique for quick multiplication of clonal root stock and scion cultivars on their own roots by heaping the normal soil in the juvenile shoots resulting in induction of better root system, which leads to higher degree of establishment under field conditions. Singh et al. (1996) observed that 5000, 7500 and 10,000 ppm IBA significantly increased the percentage of rooting and survival percentage in the stools of guava. Growth regulators caused greater mobilization of sugars and nitrogenous substances, which helped in the initiation of root primordia (Detweiler, 1942). Etiolated plants were found to have a higher level of endogenous auxin (IAA) at site of etiolation (Kawase, 1965). Majumder and Mukherjee (1968) reported that IBA induced more root in air layers. IBA (200 ppm) reduced the time for root formation and increased the number of roots (Sharma et al., 1978). Application of PBZ (2500 ppm) significantly increased rooting percentage, in stooling (Singh, 1998). Profuse rooting in stools treated with auxins has been considered to be on account of enhanced hydrolysis of nutritional reserves in root formation. Effect of different auxins could be due to their respective differences in initiating hydrolysis of nutritional reserves (Bose, 1985).

The tissue culture techniques is useful in rapid and mass multiplication of plant materials. Micropropogation refers to regeneration of plants from isolated maristemetic cells or tissues or from somatic cells. Micropropogation can be used for rapid multiplication of crop plant which are difficult to propagate sexually or those vegetatively propagated species in which rate or multiplication is slow (Singh, 1996). Similarly, studies on in vitro propagation of Psidium guajava L. demonstrate that shoot tip ex-plant from mature trees were capable of forming multiple shoot. Therefore, highest number of shoots per ex-plant were obtained from culture grown on MS medium supplemented with 1 mg g⁻¹ BAP only (Jaiswal and Amin, 1987). The growth hormones (auxins, cytokinins and gibberellins) are used for culture media formation. The auxins are mainly used to facilitate cell division and root differentiation. Commonly used auxins are IBA, NAA, NOA, P-CPA, 2, 4-D and 2, 4, 5-T. The IBA and NAA are widely used for rooting (in combination with cytokinins) for shoot proliferation. 2, 4-D and 2, 4, 5-T are very effective for the induction and growth of callus, and cytokinins or same as auxin. While GA₃ is used to induce plantlet formation from adventative embryo formed in culture (Gupta, 1997). Similarly Ramirez Villalobos et al. (1998) reported that the cytokinins (zeatin, zeatin riboside, kinetin, BA) is used to potential for development of foliar primordia and leaves in vitro culture of leaf segments of guava.

2. Plant growth

In recent year high density planting is becoming more popular using small tree densely, controlling growth by chemicals, dwarfing root stock, pruning and training (Luckwill and Child, 1973 and Looney, 1998). For this, a number of effective shoot growth retardants have been found useful in
horticulture e.g. daminozide, triazides, MH, CCC etc. are some of the well known growth retardants. Similarly, Chandra and Govind (1994) observed that ethrel (1000 and 2000 ppm) caused dwarfing effect desirably for high density planting in guava. A combination of GA₃ and BA has been found effective for training and pruning purposes (Looney, 1983). Reduction in plant height and shoot length is the usual form of growth restriction by ethephon used under ultra high density planting in guava (Mohammed et al., 1984).

3. Physico-chemical process and stress tolerance

Growth regulating chemicals influence a number of internal plant process like photosynthesis, respiration, accumulation of solutes, nutrient assimilation and pertaining. These processes determine the yield potential as well as capacity of plant to withstand adverse environmental conditions. Use of photosynthesis improving chemicals like mixatol, cytozyme, miraculan, vipul etc. have been found to increase photosynthesis efficiency, yield and quality in several fruits crops (Reis et al., 1978; Mandal and Kumar 1989, Chandra and Govind 1994 and Nandi et al., 1994). Similarly, Mandal and Kumar (1989) have reported that photosynthesis improving chemicals increased leaf area and yield of guava. While. Singh and Reddy (1992) observed that photosynthesis improving chemicals were not always effective in increasing the fruit yield of guava.

4. Flowering, fruit set and yield of guava fruits

Flower induction, flower intensity and crop regulation to a great extent can be manipulated by the use of PGR’s via; blossom or fruit-let thinning at early stage (Southwick and Veager, 1995). Similarly, Brahmachari et al. (1996) reported that in guava CCC (500 ppm) induced the earliest flowering and increased number of flowers, fruit set retention and yield, Kumar and Hoda (1977) found reduction in the number of fruits per plant in rainy season crop by the application of NAD and 2. 4-D with subsequent increase in fruit number in the following winter crop. Similar results were obtained by Singh (1986). Significant improvement in fruiting of guava as a result of GA₃ spray has been reported by (Rajput et al. 1977). GA₃ (200 ppm), spray at flower bud initiation stage increased yield of guava fruit (Ram, 1979 and Sharma et al., 1993). The profuse flowering in young guava with ethrel was also observed by Mohammed et al. (1984). Accelerated flower initiation and flowering as a result of ethephon has also been reported by Swart and Schipper (1982) and Chandra and Govind (1994).

About 80-90 per cent flowers of guava set fruits initially of which 35-60 per cent reaches to maturity while in seedless cultivar finally fruit retention is as low as 6 per cent. Sharma et al. (1993) reported that GA₃ 50, 100 and 200 ppm significantly increased fruit set. Spraying of GA₃ 15 or 30 ppm in the month of January proved effective in increasing fruit retention and subsequently the yield (Rajput et al., 1977). About 90 per cent fruit retention was also recorded in trees treated with 200 ppm GA₃ (Sundarajan et al., 1969). Application of GA₃ (1000 to 8000 ppm) in lanolin paste was found to be effective in inducing parthenocarpic fruits (Rao and Rao, 1960; Teotia et al., 1961). A spray of NAA (80 or 100 ppm) was recommended by Rathore (1975) to reduce the rainy season yield so as to increase that in the winter NAD (50 ppm) followed by 2, 4-D (30 ppm) gave better results (Kumar and Hoda, 1977). Pandey et al. (1980) obtained maximum yield in winter season by deblossoming with 800 ppm NAA followed by 600 ppm NAA. Application of growth substances like NAD (30 and 50 ppm) increased weight of fruit (Mitra et al., 1982).
Similar results were obtained by Singh (1986).

5. Crop regulation

Guava yields thrice in a year viz., rainy, winter and summer which constitute to about 70, 27 and 3 per cent yield, respectively (Shikhamany et al., 1986). The fruits harvested from rainy season crop are small in size, inferior in quality and highly susceptible to disease. Deblossoming of rainy season crop has been made by pruning, flower bud thinning, withholding irrigation and flower thinning by different PGR’s. Growth regulators and certain chemicals have been found very effective in thinning flowers and manipulating the cropping season. NAA, NAD, 2, 4-D, carbaryl and ethephon were found successful in reducing the rainy season and increasing the winter crop under different agroclimatic condition (Chundawat et al., 1975; Rathore 1975; Kumar and Hoda, 1977; Agnihotri and Bhullar, 1979; Pandey et al., 1980; Mitra et al., 1982; Singh, 1986). Teotia and Pandey (1970) observed that spraying of NAA at 100 ppm reduced the rainy season crop. Similarly, spraying of NAA and 2, 4-D were effective in thinning the summer season flowers and increasing the yield in winter (Mitra et al., 1995). Rathore (1975) reported that NAA 80 and 100 ppm greatly reduced fruit set when sprayed in April. To minimise the fruit set in rainy season crop, Singh and Singh (1975) tried NAA, MH and DNOC and found that NAA applied at 1000 and 2000 ppm through whole plant spray resulted in 100 per cent thinning of buds and flowers. Kumar and Hoda (1977) recommended NAD (50 ppm) and 2, 4-D (30 ppm) for thinning rainy season crop. Agnihotri and Bhullar (1979) reported significant reduction in fruit set (74-86.6 per cent) by using NAA, carbaryl and ethephon. Pandey et al. (1980) recorded a high flower bud abscission by spray of NAA (800 and 600 ppm) and 2, 4-D (100 and 500 ppm) which consequently resulted in reduced fruit set during rainy season. In the following winter, although the treatments reduced number of flower buds but the per cent fruit set improved. Mitra et al. (1982) reported that NAA, NAD and 2, 4-D caused blossom drop in guava, the most promising being 50 ppm NAD giving only 10.5 per cent fruit set compared to 70 per cent in control. 2, 4-D 30 ppm also caused marked reduction (20.5 per cent) in fruits set and consequently in the following winter fruit set increased markedly to 80.8 and 77 per cent, respectively. Gupta and Nijjar (1982) found that 600 ppm NAA caused the highest shedding of blossom and young fruitlets. Singh (1986) found NAD (50 ppm) to be very effective in reducing rainy season crop with subsequent increased fruit set in winter. Application of NAA (800 ppm) has been found useful to get a good winter crop (Tiwari and Lal, 1984, Singh and Reddy, 1997).

6. Shelf-life and quality of fruits

Guava is a delicious and one of the highly perishable fruit among other tropical and subtropical fruits and therefore, cannot be stored for longer period under ordinary room temperature without checking the rate of transpiration, respiration and microbial infection. Certain pre and post harvest treatments like, GA3, 2, 4-D, CCC, MH, BA have been reported to increase the shelf life and reduce spoilage in guava (Saha, 1971). Similarly Patel et al. (1993) have delayed the ripening process and extended the shelf life of fruits Dashora and Mohammed (1999) Jagadeesh and Rokhade (1998) also support these findings.

Singh and Reddy (1997) reported that ethaphon and NAA significantly decreased number of fruit but increased fruit weight, fruit length and quality parameters. The maximum length of fruit in rainy season crop was noted in plants treated with NAD (30 ppm), while fruit length in winter was maximum in 2, 4-D treated plants. The length and diameter of fruits
also increased by the use of growth substances (Mitra et al., 1982). It has been reported by Babu and Shanker (1977) that 12 ppm 2, 4-D increased the TSS in Allahabad safeda. The NAA (40 and 80 ppm) improved TSS in guava (Rajput et al., 1977). At saubour chemical treatments also influenced the TSS and total sugars of Allahabad safeda guava fruits, 50 ppm. NAD gave the best results in both the season (Singh, 1986). Mitra et al. (1982) reported minimum acidity by the spray of 100 ppm NAA. Singh (1986) also reported that NAA (100 ppm) reduced the acidity. Application of 12 ppm 2,4-D increased pectin, sugar and vitamin C content in guava fruits (Babu and Shanker, 1977). Mitra et al. (1982) also found maximum vitamin 'C' content in the fruits treated with 125 ppm NAA in both rainy (174.6 mg/100g) and winter (253.7 mg/100g) seasons. The untreated plants had minimum vitamin C content. In similar studies. NAD (50 and 75 ppm) and pruning treatments increased the vitamin C content of guava fruit (Singh, 1986). Mitra et al. (1982) registered maximum total sugar by NAD (30 ppm). Whereas NAD (50 ppm) treatment significantly increased the pectin content of guava as reported by Singh (1986).

**CONCLUSION**

The literature available reveals that application of different plant bio-regulators and chemicals have great potential to improve germination per cent, better vegetative growth, help in plant propagation, develop stress tolerance, induction of flowering, enhanced flowers and fruit retention. These are also helpful in fruit ripening, improving quality and yield. The efficient utilization of which can provide a dramatic change in fruit production and despite all success in high density planting and improving storage life of the fruits without any spoilage. It is expected that this knowledge will be used to develop new chemicals to be utilized to enhanced fruit production in further. Thus, it can be concluded that plant growth regulators can be effectively used for improving seed germination, root formation, plant growth, yield, fruit quality and shelf-life of guava if, application at proper time and manner in suitable doses.

**REFERENCES**