International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(3): 1609-1613

Received: 04-03-2019
Accepted: 08-04-2019

G Nirmala Devi
Department of Spices and Plantation crops, HC&RI, Periyakulam, Tamil Nadu, India

P Jansi Rani
Department of Spices and Plantation crops, HC&RI, Periyakulam, Tamil Nadu, India

R Chitra
Department of Spices and Plantation crops, HC&RI, Periyakulam, Tamil Nadu, India

K Venkatesan
Department of Crop Physiology, HC&RI, Periyakulam, Tamil Nadu, India

Correspondence
P Jansi Rani
Department of Spices and Plantation crops, HC&RI, Periyakulam, Tamil Nadu, India

Effect of plant growth regulators and nutrient spray on fruit set, pod yield and quality in tamarind (*Tamarindus indica* L.)

G Nirmala Devi, P Jansi Rani, R Chitra and K Venkatesan

Abstract
A study was conducted on the influence of plant growth regulators and nutrient as foliar spray on fruit set, pod yield and quality of Tamarind (*Tamarindus indica.* L) at Horticulture College and Research Institute, Periyakulam during 2018-2019. Different concentrations of Plant growth regulators viz NAA (25 and 50 ppm), GA_3 (20 and 40 ppm) and nutrient KNO_3 (0. 25 and 0. 5 percent) were sprayed on Tamarind variety PKM-1 during vegetative and flowering period. The performance of trees treated with plant growth regulators and nutrient were better than the untreated trees. The percentage of fruit set (82. 30), number of pods per tree(9180), pulp weight (15. 4), pod yield (163) were found to be maximum on the trees treated with NAA 25 ppm while the length of the pod (13. 0 cm), seed weight (10g) were found to be the highest on the trees sprayed with KNO_3 at 0. 5 percent concentration. The maximum number of seeds (10) was observed on the trees sprayed with KNO_3 at 0. 2 percent concentration. Investigations on biochemical attributes revealed that the highest chlorophyll content (3. 71mg/g) was observed in KNO_3 at 0.2 percent concentration. The highest total soluble protein (2. 85gper 100 g) was observed in KNO_3 with the concentration of 0.5 percent treated trees of tamarind. The best utilization of C:N ratio in wood was noticed on the tamarind trees applied with NAA at both the concentrations of 25 ppm followed by 50 ppm. The results of the study have shown that the significant role of NAA at 25 ppm concentration to enhance the fruit set percentage and yield parameters in tamarind. The estimation of biochemical parameters revealed that KNO_3 was found to be responsible on improving the biochemical traits and C:N ratio which would have influenced the pod yield.

Keywords: Tamarind, growth regulators, fruit set, pod yield, quality

Introduction
Tamarind (*Tamarindus indica*. L) is one of the wide spread trees of Indian subcontinent. It is a member of dicotyledon belonging to the family Fabaceae and sub family Caesalpinaceae with chromosome number 2n=24 (Purseglove, 1987) [17]. The term tamarind is derived from an Arabic word “Tamarind-E-Hind” meaning “Date of India” popularly known as “Indian Date”. Tamarind is native to Tropical Africa. India is the main producer and consumer of tamarind in the world. It is a large evergreen tree growing to a height of 30m and above with large trunk size of about 8m circumference and a crown diameter of 12 m. Almost all parts of the tree find a use in food, chemical, pharmaceutical, textile industries, or as fodder, timber, wood and fuel (Dagar *et al*., 1995) [5] It starts bearing the fruits at the age of 8 to 10 years and continue to produce fruits even after 60 years and above. It yields fruits as thick shelled brown colour pod covering the inner cinnamon or brown coloured pulp which is the economic part of the tree and commercially known as tamarind plum.
Tamarind is a multipurpose plant. The pulp of the fruit has been used as a spice in Asian cuisine, especially in southern parts of India, for a long time. The pulp is used for preparation of rasam, a favorite delicacy of south Indian food known for its digestive value. Toffees, candies are also prepared from tamarind pulp which are popular in airlines service. Preparation of candies is also taken by cottage industries in Karnataka, Maharashtra, and other tamarind growing states of India. It is widely used as a spice for souring curries, chutneys and certain beverages. In recent years, there is a vast development on road expansion where a sizable population of tamarind trees are removed thereby tamarind production is affected remarkably. In Tamarind, nearly halfof the pod weight is contributed by pulp. It contains both sugars (30-40%) and organic acids (8-18%) predominantly tartaric acid. The pulp is a rich source of vitamins, minerals, calcium (81-466mg/100g)

Potassium (62-570mg /100g), Iron (1. 3-10. 9 mg/100g) etc.
Tamarind pulp constitutes 30-50% of the ripe fruit (Purseglove, 1987) [17]. The shell and fibre account for 11-30% and the seed constitutes about 25-40% (Chapman, 1984). The seed consists of the seed coat or testa (20-30%) and the kernel or endosperm (70-75%) (Coronel, 1991) [4]. The seed is rich in protein (13-20%) and oil (4. 5-16. 2%). The seed coat is rich in fibre (20%) and tannins (20%). It is traditionally propagated from seeds. It produces relatively large size seeds that are about 11-12. 5 mm in diameter. The seeds begin to germinate in about 13 days after sowing and a month to complete. Just like mango, tamarind also exhibits irregular or alternate bearing and the percentage of fruit set is also very low. There is a growth habit of “on” and “off” years of flowering and harvest which affects the pod and pulp yield of tamarind considerably, Hence a study on effect of plant growth regulators and nutrients spray on fruit set, pod yield, quality of tamarind was under taken.

Materials and Methods

An investigation was carried out at Department of Spices and Plantation crops, Horticulture College and Research Institute, Periyakulam on grown up trees of PKM_1, Tamarind with uniform canopy size at a spacing of 8m×8m distance. Twenty one trees were selected nearly similar in vigour and size. The aim of the experiment was to study the influence of growth regulators and nutrient spray on flowering and fruiting in Tamarind. The experimental design was randomized block design. The experimental treatments were seven with three replications as follows (Table 1).

The foliar sprays of NAA, GA_3, KNO_3 were given at vegetative and also at flowering stage during the months of August and September (2018) until then there was no flowering on tamarind trees. In general, tamarind trees flower from April to June and the ripened fruits are harvested from March to April. The observations on fruit set percentage, number of pods per tree, pulp weight, pod yield per tree, length of the pod, number of seeds per pod, seed weight and also the biochemical observations viz…total chlorophyll content and total soluble protein content in leaves and C:N ratio in the wood were recorded. The data were recorded before flowering and after fruit set and statistical analysis were carried out as per the method suggested by Panse and Sukhatme (1969).

Results

The effect of plant growth regulators and nutrient spray on fruit set, pod yield, quality of tamarind was studied on PKM-1 variety of tamarind trees. The response of the tamarind trees due to the foliar spray of growth regulators viz…NAA at 25 and 50 ppm, GA_3 at 20 and 40 ppm, and the nutrient KNO_3 at 0. 25 and 0. 50 percentage were recorded in terms of fruit set percentage, number of pods per tree, pulp weight (g), pod yield per tree (kg), length of the pod(cm), number of seeds per pod, seed weight per pod(g) and also the biochemical traits such as total chlorophyll content, total soluble proteins in leaves and C:N ratio in wood were estimated.

Among the pod and pod yielding traits, the highest fruit set percentage (82. 30) was noticed in the treatment T_1 (NAA-25 ppm) while the lowest fruit set percentage was observed on the treatment T4 (GA3-40ppm) (32. 3). The treatment T_1 (NAA-25ppm) recorded the highest number of pods per tree (9180) followed by T_3 (GA3-20ppm) (8908) while the lowest number of pods per tree was recorded in the treatment T_4(GA_3-40 ppm) (5670). The pulp weight per pod was noticed to be highest in the treatment T_1 (NAA-25ppm) (15. 40g) followed by T_2 (NAA-50ppm) (12. 10g) while the least value of pulp weight per pod was observed in treatment T_3(GA_3-20 ppm) (7. 50g). The highest pod yield per tree was observed in T_1 (NAA-25 ppm) **(**163. 0kg per tree) followed by T_2(NAA-50ppm) (153. 0 kg per tree) while the least value was observed in T_7(Control) (91 kg per tree) (Table-2)

Among the fruit characters which contribute towards the yield, the length of the pod was observed to be the highest in the treatment T_6 (KNO_3-0. 50 ppm) (13. 0cm) followed by T_5 (KNO_3-0. 25ppm) (12. 50cm) while the length of the pod was observed to be the least in the treatment T_7(Control) (7. 0cm). The number of seeds per pod was observed to be least in the treatment T_7 (Control) (8. 5) followed by the treatment T_3 (GA_3-20 ppm) (7. 15) While the highest number of seeds per pod was observed in the treatment T_6 (KNO_3-0. 50 ppm) (10. 0). The least seed weight per pod was observed in treatment T_5(KNO_3-0. 20 ppm) (7. 00g) followed by T_3 (GA_3-25 ppm) (7. 15g) while the highest value of seed weight was observed in the treatment T_6 (KNO_3-0. 50ppm) (10. 0g) preferably (Table-2)

The biochemical traits viz…total chlorophyll content, total soluble protein in leaves and C:N ratio in wood were also estimated and were also interpreted as follows. The estimation of total chlorophyll content in tamarind leaves was observed to be the highest on trees treated with T_5 (KNO_3-0. 25ppm) (3. 71mg per g) followed by the treatment T_3(GA_3-20 ppm)(3. 44mg/g) while the least content was observed on the trees sprayed with in T_1(NAA-25 ppm)(2. 98mg per g). The maximum total soluble protein content in leaves was recorded in the treatment T_6 (KNO_3-0. 50 ppm) (3. 85g per 100g) followed by T_5 (KNO_3-0. 25ppm) (3. 80g per 100g) while in the control T_7(Control)(3. 65g per 100g) the least value was noted. Similar trend was noticed in the treatment T_2 (NAA-50ppm) (3. 65g per 100g).

The highest C:N ratio utilization in wood was observed on the trees treated with T_1(NAA- 25 ppm) followed by T_2 (NAA-50ppm) (0. 37) while the least utilization ratio was observed in T_5(KNO_3-0. 25ppm) (0. 98) followed by T_7(Control)(0. 84)

Discussion

The study on influence of plant growth regulators and nutrient spray on fruit set, yield, quality of tamarind have shown that the highest fruit set percentage of 82. 30percentage was recorded in the trees sprayed with NAA at 25 ppm because the application of NAA would have reduced the fruit drop and increased the number of fruits to be set. Though plant growth regulators have great potential to influence plant growth morphogenesis but its application have to be judiciously planned in terms of optimal concentration, which constitute the major impediments in plant growth regulators applicability. In this study, it was proved that application of NAA improves fruit set because of the reduced significant fruit drop which increased fruit size. Uniyal *et al*., (2015) found that NAA 20 ppm significantly increased the fruit set percent in Bael cv. Pant Shivani. In yet another study, Vinita Rajput. *et.al* (2017) [23] also observed high fruit set due to the application of NAA 10 ppm in *Prunus salicina* and also NAA reduces flower drop which gave high flower retension in mango as investigated by Vijendha *et al*., (2008) and Nkansah *et al*., (2012) [14]. Hence the treatment NAA at 25 ppm could be adjudged as the best performing treatment to induce flowering, fruiting and good pod production in tamarind among the different chemicals utilized in this study.

The pulp is the product of tamarind, some tamarind trees with more pod weight may also give less pulp weight. In tamarind, observations on number pods per tree is also yet another important yield contributing trait. The increase in pod number have direct effect on yield improvement. In this study the highest number of pods per tree was estimated on trees sprayed with (NAA-25ppm) (9180) followed by (GA3-20ppm) (8908). The increase in pod yield might be due to the increase in number of flowers per cluster which contributed towards the increase in number of fruits per tree. The similar result was observed by Vejendla *et al.*, (2008) [24] in mango cv. Amarapalli with the foliar application of NAA. Lal *et al*., (2015) [13] sprayed different doses of GA3 and NAA on improving the yield of Kinnow mandarin and among them the application of NAA 20 ppm followed by GA3 100 ppm were found to be more effective and increased the number of fruits per tree. These findings were also found to be inline with the present findings of improvement in the pod yield of tamarind by the application of NAA followed by GA_3.

Fruit pulp or fruit plum is the real economic part of tamarind. The fruit pulp is generally fleshy which is acidic in taste and used in preparation of many food products like candies, toffee, health drinks, etc. The Pulp weight per pod was observed to be the highest on tamarind trees sprayed with NAA-50ppm (15. 40 g). Similar results were also recorded in guava by Katiyar *et al*., (2009) [12] who have reported the increase in fruit size due to the strengthening of middle lamella and consequently cell wall which might have increased the free passage of solutes to the fruit. In aonla cv. NA-7 by Gautam Jangid *et al*., (2018) also noticed increase in fruit size due to the application of growth regulators. He had explained the role of auxin the growth regulator, that would have accelerated and maintained the on-going physiological and biochemical process of inhibition of abscission (Taylor and Whitelaw, 2001 and Aziz, 2003) [21, 1] Further the increase in fruit weight and volume were also observed by the application of NAA that might be due to the cell enlargement, cell division, increase in intercellular spaces in the mesocarpic cells, higher translocation of photosynthates and mineral nutrients from vegetative parts towards the developing fruits that were considered as the extremely active metabolic sink, was also evidenced by Krishnamoorthy, (1993) [10].

Enhancement of pod yield through organic and inorganic inputs like manures, fertilizers and also by growth regulators is the primary objective in any yield improvement programme. In this study also, spraying of growth regulators and nutrients were attempted and the results have shown that the highest pod yield per tree was observed on the trees sprayed with NAA-25 ppm **(**163kg per tree) followed by the treatment NAA-50ppm (153 kg per tree). Ghosh *et al*., (2006) [9] also noted the similar results of high fruit yield in pomegranate by the application of NAA at 25 ppm significantly yet another yield increasing trait as it would directly increase the pulp weight of tamarind pod preferably. Here the increase in length (13. 0cm) of the pod was obtained by the treatment (KNO_3-0. 50 ppm). Similar reports of increase in the fruit size of Kinnow mandarin by the foliar application of $KN0_3$ was reported by Sangwan *et al*., (2008) [20] and also in ber var Umran by Rachna arora and sukhdev singh (2014) [18] In this trial also, the increase in fruit length could be attributed to the accelerated involvement of plant growth regulators in cell division, cell expansion and increased volume of intercellular spaces in the mesocarpic cells and improved the morphogenesis of the plant organ, i. e the increased length of the pod

In tamarind pod, seed constitutes 30 percent roughly and less weight of seed per pod is preferred. The maximum seed weight per pod was observed in treatment T_6(KNO_3-0. 50 ppm) and similar result were also observed in cashew (2%KNO_3) by Palsande *et al*., (2013) and followed by T_1(NAA-25 ppm) (8. 95)in this study which was also observed by Osama *et al*., (2015) [15] in both the concentrations of NAA at 25 and 50 ppm.

In green plants chlorophyll is the major pigment involved in photosynthesis and it would result in growth and yield of crop plants. The increased level of total chlorophyll content in tamarind leaves was observed in the trees sprayed with KNO_3 at 0. 25 percent concentration. These results are in conformity with the results obtained by Debaje *et al*., (2010) [6] who have mentioned that the potassium indirectly improves the photosynthesis in citrus (*Citrus aurantifolia*).

The nutrient “K”plays a major role in the quality while the “N” is a major component of all proteins (including all enzymes), amino acids, nucleic acids. In photosynthesis potassium regulates the opening and closing of stomata, and therefore regulates CO2 uptake and synthesis of food materials and improves the pod yield. Potassium is an essential nutrient at almost every step of the protein synthesis. In starch synthesis, the enzyme responsible for the process is activated by potassium nutrient. In the present study the total soluble protein was also found to be maximum on KNO_3 at both the concentrations 0. 2 and 0. 5 percent which might be due to the protein and starch synthesis in crop plants that requires potassium nutrients as well.

Sachs *et al*., (1977) [19] reported that the floral induction in plants was stimulated by source and sink relationship in such a way that shoot apical meristem receives a better supply of carbohydrates and this was merely irrespective of the environmental conditions involved(day length, vernalization etc). Kannan *et al*., (2009) [11] conducted carbon assimilation studies and reported that in paprika that the highest carbon assimilation in plants influence the plants to absorb the nutrients efficiently and that was well utilized for its growth and development. Further it was also opined that by narrowing the C:N ratio, the early bud initiation would have been resulted. Bernier *et al*., (1981) [2] also narrated that the high carbon content would favour photosynthetic CO_2 fixation which would induce flowering while high nitrogen content would favour vegetative growth. In this study, the C:N ratio was highly utilized by the trees sprayed with NAA at both the concentrations (25, 50 ppm) which influenced more flower production which resulted in high pod yield and quality.

Conclusion

The present study on the effect of foliar application of plant growth regulators and nutrient spray on fruit set, yield and quality of tamarind revealed that foliar application of NAA (25ppm) at vegetative and flowering stage was found to increase the fruit set percentage, maximum pulp weight, pod yield per tree and also enhances the quality by increasing the utilization of C:N ratio at both the concentrations of NAA(25, 50) ppm. According to the quality parameters (total soluble protein and chlorophyll content) KNO_3 proved to play a significant role.

Table 1: Treatment details

Treatments	Treatment details
T_1	Naphathalein Acetic Acid at 25 ppm
T_2	Naphthalin Acetic Acid at 50ppm
T_3	Gibberellic acidat 20 ppm
T_4	Gibberellic acid at 40 ppm
T_5	Potassium Nitrateat 0. 25 percentage
T_6	Potasium Nitrateat 0. 50 percentage
T_7	Water spray(Control)

Table 2: Effect of plant growth regulators and nutrient spray on fruiting and pod yield of Tamarind var PKM-1

Treatment	Fruit set percentage (%)	Number of pods per tree	Pulp weight (g)	Pod yield per tree (kg)	Length of the pod (cm)	Number of seeds per pod	Seed weight (g) Per pod
T_1	82. 3	9180	15. 4	163	10. 0	9. 5	8. 95
T_2	66. 6	8150	12. 1	153	9. 5	9. 5	8. 80
T_3	67. 9	8908	7. 5	131	11. 5	9. 0	7. 15
T_4	32. 3	5670	10	135	12. 0	9. 0	7. 25
T_5	41. 4	7100	10. 5	142	12. 5	10. 0	7. 00
T_6	35. 5	5760	11. 5	144	13. 0	9. 5	10. 00
T_7	57. 1	6188	11. 5	91. 00	7. 00	8. 5	7. 25
Mean	54. 7	7279	11. 2	137	10. 7	9. 2	8. 05
SEd	0. 47	58. 00	0. 12	1. 48	0. 08	0. 15	0. 18
C. D(0. 5)	1. 03	126. 36	0. 26	3. 23	0. 18	0. 33	0. 38

Table 3: Effect of plant growth regulators and plant nutrients on quality parameters of tamarind var. PKM-1

Treatment	Total chlorophyll in leaves (mg/g)	Total soluble proteins in leaves(g/100g)	C:N ratio in wood	
			Before treatment	After treatment
T_1	2. 98	3. 75	1. 10	0. 37
T_2	3. 19	3. 65	1. 25	0. 37
T_3	3. 44	3. 70	1. 20	0. 40
T_4	3. 24	3. 72	1. 25	0. 47
T_5	3. 71	3. 80	1. 16	0. 98
T_6	3. 42	3. 85	1. 19	0. 38
T_7	3. 34	3. 65	1. 17	0. 84
Mean	3. 33	3. 73	1. 18	0. 54
SEd	0. 08	0. 04	0. 02	0. 01
C. D(0. 5)	0. 18	0. 08	0. 05	0. 02

References

1. Aziz A. Spermidine and related-metabolic inhibitors modulate sugar and amino acid levels in *Vitis vinifera* L.: possible relationships with initial fruit let abscission. Journal of Experimental Botany. 2003; 54(381):355-363.
2. Bernier G, Kinet J, Sachs RM. The physiology of flowering, Edn 1, Vol. 1, CRC Press, Boca Raton, 1981.
3. Chapman, KR. Tamarind. In Tropical Tree Fruits for Australia., Queensland Department of Primary Industries, Information series Q183018, Brisbane, 1984, 83-86.
4. Coronel RE, Verheij EWM, *Tamarindus indica L*. In Plant Resources of South East Asia No 2, PROSEA Foundation, Bagor, Indonesia. 1991, 293-301.
5. Dagar JC, Singh NJ and Singh G. Evaluation of crops in agroforestry with teak, (*Tecona grandis)* Maharukh (*Ailanthes excelsa*) and Tamarind (*Tamarindus indica* L.) on reclaimed salt affected soil. Journal of Tropical Forest Science. 1995; 7(4):623-624.
6. Debaje PP, Ekta D, Shinde and Ingale HV, Effect of plant growth regulators and nutrients on quality of Acid lime (Citrus aurantifolia Swingle). The Asian Journal
7. of Horticulture. 2011; 6(1):253-255.
8. Goutam Jangid, Goutam Mandal, Kamal Kumar Mandal and Rocky Thokchom. Foliar application of plant growth regulators to improve fruit retention, yield and quality of aonla cv. NA-7. Journal of Pharmacognosy and Phytochemistry. 2018; 7(3):21-26.
9. Ghosh SN, Bera1 B, Roy1 S and Kundu1 A. Effect of plant growth regulators in yield and fruit quality in pomegranate cv. Ruby. Journal of Horticultural Science. 2006; 4(2):158-160.
10. Krishnamoorthy HN. Physiology of plant growth and development. Atma Ram and Sons Publishers, 1993.
11. Kannan K, Jawaharlal and Prabhu M. Effect of plant growth regulators on growth and yield parameters of paprika cv. ktpl-19. Agricultural science digest. 2009; 29(3):157-162
12. Katiyar PN, Singh JP and Singh PC. Effect of nutrients and plant growth regulators on physico-chemical parameters and yeild of guava (Psidium guajava L.) fruit cv. Allahabad Safeda. International journal of Agricultural science. 2009; 5(1):173-174
13. Lal D, Tripathi VK, Kumar S and Nayyer, MA. Effect of preharvest application of gibberalic acid, NAA and calcium nitrate on fruit drop and storage quality of Kinnow mandarin. Research in Environment and Life Sciences. 2015; 8(4):561-612.
14. Nkansah GO, OfosuAnim J and Mawuli A. Gibberellic acid and naphthalene acetic acid affect fruit retention, yield and quality of Keitt mangoes in the coastal Savanna ecological zone of Ghana. American Journal of Plant Physiology. 2012; 7(6):243-351.
15. Osama HM, Gammal; Amro El, Salama and Saber SM, Bakeer MM. Effect of Growth Regulator, Antioxidant and Application Date on Fruiting and Fruit Quality of

Mango Trees cv. Keitt. Journal of Agriculture and Veterinary Science. 2015; 8(12):87-95.
16. Palsande VN, Dabke DJ, Kasture MC, Khobragade NH and Patil SD. Effect of urea, potassium nitrate and insecticides through foliar application on growth, yield and quality of Cashewnut BIOINFOLET. 2013; 10(1B):347-349.
17. Purseglove JW. Tropical crops. Dicotyledons, Longman Science and Technology, 1987, 204-206.
18. Rachna Arora and Sukhdev Singh. Effect of Growth Regulators on Quality of Ber (Zizyphus Mauritiana Lamk) CV. Umra. Agricultural Science Digest. 2014; 34(2):102-106
19. Sachs RM and Hackett WP. Chemical control of flowering. Acta Horticulturae. 1977; 68:29-49.
20. Sangwan AK, Rattanpal HS, Arora NK and Dalal R. S Effect of foliar application of potassium nitrate on fruit yield and quality of Kinnow mandarin. Journal of Environmental Ecology. 2008; 26(4C):2315-2318.
21. Taylor JE, Whitelaw CA. Signals in abscission. New Phytologist. 2001; 151(2):323-339.
22. UniyalS, Misra KK. Effect of plant growth regulators on fruit drop and quality of Bael under Tarai conditions of Uttarakhand. Indian Journal of Horticulture. 2015; 72(1):126-129.
23. Vinita Rajput, SehrawatSK, and BhatiaSK. Growth regulators and nutrient application reduces fruit drop and improves fruit Quality in *Prunus salicina* Lindl. cv. Kala Amritsari. International journal of Pure and applied bioscience. 2017; 5(1):735-743.
24. Vejendla V, Maity PK and Bank BC. Effect of chemicals and growth regulators on fruit retention, yield and quality of mango cv. Amrapali. Journal of Crop and Weed. 2008; 4(2):45-46.