The Pharma Innovation Journal 2023; 12(10): 1792-1795

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 1792-1795

www.thepharmajournal.com
Received: 20-07-2023
Accepted: 26-08-2023

Kajal Jaiswal
Department of Fruit Science, Institute of Agricultural Sciences, Siksha 'O' Anusandhan University, Deemed to be University, Odisha, India

Anasuya Mohanty
Department of Fruit Science, Institute of Agricultural Sciences, Siksha 'O' Anusandhan University, Deemed to be University, Odisha, India

S Mishra
Department of Fruit Science, Institute of Agricultural Sciences, Siksha 'O' Anusandhan University, Deemed to be University, Odisha, India

Corresponding Author:
Kajal Jaiswal
Department of Fruit Science, Institute of Agricultural Sciences, Siksha 'O' Anusandhan University, Deemed to be University, Odisha, India

Effect of PGR on yield, quality and shelf life of custard apple

Kajal Jaiswal, Anasuya Mohanty and S Mishra

Abstract
Custard apple (*Annona squamosa*) is a tropical fruit known for its unique flavor and nutritional value. However, its yield, fruit quality and post-harvest shelf life are often compromised due to various factors, including environmental stress and pest infestations. This review compiles and analyzes the existing body of research on the effects of PGRs on custard apple crops, with a particular focus on their influence on yield, fruit quality, and shelf life. PGR-treated trees exhibited increased fruit yield, larger fruit size, and higher fruit weight compared to the control group. Additionally, PGR-treated fruit had a higher sugar content and improved taste due to increased sugar-to-acid ratios. Furthermore, PGR-treated custard apples demonstrated enhanced post-harvest shelf life. The fruits exhibited reduced physiological disorders, such as fruit rot and shriveling, and maintained their quality and marketability for a more extended period. This extended shelf life is of significant economic importance for both growers and consumers. The application of PGRs in custard apple cultivation has the potential to enhance fruit yield, improve fruit quality, and extend the post-harvest shelf life of the fruit.

Keywords: Crop management, custard apple, *Annona squamosa*, yield enhancement, fruit quality and shelf life

Introduction
Due to the changing climate more attention has been given to those crops which can sustain the adverse climatic effect. Custard apple is one among them, as it is a very hardy crop, with shallow rooted system, but requires very less moisture for better production. Custard apple (*Anona squamosa*,) belongs to the family Annonaceae, is a delicious fruit originated at tropical America. The family consists of various other popular species like, Ramphal (*A. reticulate*), Hanumanphal, Laxmanphal, Pond apple etc. After introduction to India by Portuguese from its centre of origin, it acclimatized to our country very well hence a wide gene pool has been observed in wild areas of Assam, Maharashtra, Madhya Pradesh, Odisha etc.

Annona fruits have considerable importance in human nutrition, medicinal and cultural events (Thakur and Singh, 1967) [12]. The fruits are rich source of Carbohydrate (mainly Glucose and Sucrose), fibers, calcium, phosphorous, iron along with vitamins like B_1, B_2, B_4, B_6 and Vitamin-C (Brand-Miller *et al*., 2003) [4]**.** The Health Benefits offered from Annona sps. are due to their wide diversity in phytochemicals (phenolic and flavonoid compounds having antioxidant activity), volatiles and flavour components (food industry), acetogenins (anti-cancer properties), anti-obese activity, anti-diabetic properties and anti-microbial/viral/fungal activity. Due to immense health benefits, it is known as "The New Super Fruit of the 21st Century" (George, 2018) [6]

Annona sps. are being cultivated in various countries Australia, Brazil, Burma, Egypt, India, Mexico, Philippines, Spain, Srilanka, Africa, USA and West Indies etc. As it is a minor crop, mostly grown in forest and backyard the proper data is not available. According to APEDA Agri Exchange (2015-16) in India, it is cultivated in an area of 35,000 ha with a production of 298.64 thousand T. The top producing states are Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh, Telengana, Karnataka, Andhra Pradesh *etc*. The production of Maharashtra is 92.32 thousand T (30.98%) followed by Gujarat (61.18 thousand T or 20.53%) and Madhya Pradesh 56.74 thousand T (19.04%). These three states account for more than 70% of nation's production of Custard apple. Various constraints in the production, storage and quality of this crop are there in scientific interventions, farmer's field and consumers as described below.

Problems of Farmers

- **Quality planting materials:** Budded or Grafted seedlings from a desirable or superior mother plant are not available at proper time.
- **Poor fruit set and retention:** There is more number of flowers in a branch but ultimately only 1-2 reaches to the maturity. In general 1-8% fruit set is observed in this crop which can be increased up to 15-25% by hand pollination along with application of growth regulators which increases the yield of crop.
- **Poor quality fruit:** Fruit contains more number of seeds and contains various inferior quality parameters like low TSS, sugar and more acidity etc.
- **Proper transportation:** After attainment of harvesting maturity the fruit can be stored for a shorter period, hence required quick and controlled transport to the market. The fruit seller doesn't have idea on the climacteric behavior and store custard apple at one place. If a single fruit is ripe in the lot, it will aggravate the ripening process of other fruit by accelerating the ethylene synthesis. In India we don't have proper packaging system, and farmers mostly use the plant twig or leaves as cushioning materials. The detached plant tissue enhances the ethylene production in the matured fruit and lowers the fruit shelf life.
- **Low storage life:** In room temperature it can be stored up to 2-3 days without reduction in the quality and in refrigerated condition for 3-4 days.

Problems to Scientists

- Wide but distributed Genetic diversity
- Grown mostly in wild areas
- No Area specificity in cultivation
- Minor fruit crop so low interest for research
- Floral structure need special attention
- Seediness in fruit
- Greitiness of fruit pulp
- Physical characteristics of fruit at ripening: suddenly after fruit maturity the degradation process begins.

Problems to Consumers

- Seasonal availability
- Seediness in fruit
- Greitiness of fruit pulp
- Low shelf life: (3-4 days in Refrigerated and 2-3 Days in room temperature)

Interventions needed on

The following areas for the enhancement of yield, quality and shelf life in custard apple needs specific interventions. For yield**,** quality planting materials of improved cultivars, high fruit set and retention, efficient photosynthate distribution, for quality: greater TSS, Pulp: Seed, Sugar content, less Greit cells and for shelf life: Lesser evolution of ethylene, Low auto-degradation are the desired features.

Plant growth regulators if applied at specific time in specific quantity can enhance the desirable production and quality while increasing the shelf life. Various reviews have been analyzed to compile the data on enhancing yield, quality and shelf life of Custard apple by application of Plant Growth Regulators is discussed below.

Use of PGR for enhancing yield of custard apple

Mahorkar *et al*. (2018) [8] at VNMKV, Parbhani, Maharashtra studied observed that NAA @ 100 ppm increases the number of flowers per shoot which is at par with GA_3 @ 75 ppm. It might be due to application of PGR makes the plant physiologically more active to build up sufficient food stock for the developing flower. The other parameters like high fruit set, less fruit drop, more fruit per plant or fruit retention and more yield were obtained with application of GA_3 @ 75 ppm which is at par with NAA @ 100 ppm. This might be as a result of induction of cell division, elongation, maintenance of cell osmotic concentration and RWC, production of auxin, which suppress the abscission layer formation there by reducing fruit drop and enhancing the yield.

Use of PGR for enhancing quality of custard apple

An experiment was conducted by Chaudhari *et al*. (2017) [5] at JAU, Junagadh on where the plant growth regulators were sprayed three times at five days interval during peak flowering stage (July). The treatment GA_3 @ 50 ppm has significantly superior to other treatments in terms of TSS, acidity, reducing sugar, non reducing sugar, total sugar and ascorbic acid, which might be due to the action of GA_3 on converting complex substances into simpler one, thus maintain the osmotic potential of fruit cells hence improving the quality.

Thorat *et al*. (2018) [13] at Custard Apple Research Station, Ambajogai, MR, studied the "Influence of Growth Regulators on Quality and Fruit Attributes of Custard Apple (*Annona squamosa* L.) CV. Balanagar" with 10 treatments {T_1: GA_3 25 ppm, T_2: GA_3 50 ppm, T_3: GA_3 75 ppm, T_4: NAA 10 ppm, T_5: NAA 20 ppm, T_6: NAA 30 ppm, T_7: GA_3 25 + NAA 10 ppm, T_8: GA_3 50+NAA 20 ppm, T_9: GA_3 75+NAA 30 ppm and T_{10}: control (water spray)} each replicated thrice. Spraying of chemicals were done before flowering (second fortnight of May) and one month after the first spray. He observed T_7 (GA_3 @ 25 ppm along with NAA @ 10 ppm) provided the significantly better result in terms of TSS, acidity and sugar content of the custard apple fruits.

The same author at the same place studied the fruit attributes of another variety in experiment entitled **"**Effect of plant growth regulators on quality of Custard apple (*Annona squamosa* L.) CV. Sindhan". He observed that T_7 (GA_3 @ 25 ppm along with NAA @ 10 ppm) improve the fruit length, fruit diameter, weight of pulp, fruit volume and less peel weight, seed to pulp ratio, number of seeds and seed weight.

Mahorkar *et al*. (2018) [8] at VNMKV, Parbhani, Maharashtra studied the "Effect of PGR on TSS (° Brix) and Number of seed per Fruit of Custard apple". He has taken ten treatments namely T_1: NAA 50 ppm, T_2: NAA 75 ppm, T_3: NAA 100 ppm, T_4: GA_3 50 ppm, T_5: GA_3 75 ppm, T_6: GA_3 100 ppm, T_7: Ethereal 100 ppm, T_8: Ethereal 200 ppm, T_9: Ethereal 300 ppm and T_{10}: control (water spray). Application of NAA and GA_3 reduces the number of seed per fruit where as ethereal enhances it. The T_5 (GA_3 @75 ppm) recorded the maximum TSS and 2nd best result in lowering the number of seed per fruit.

Shivakumar *et al*. (2018) [11] at UHS, GKVK campus, Bengaluru studied "Effect of Gibberellic Acid and Assisted Pollination on Fruit Characters of Custard Apple cv. Arka Sahan" and suggested that GA3 @ 1000 ppm along with hand

pollination recorded maximum fruit weight, pulp weight, peel weight, pulp recovery, pulp: pell and reduced the percentage of peel content.

Use of PGR for enhancing shelf life of custard apple

The fig. 1 and 2 indicates various flower and fruit developmental stages. 1st row indicate the fully mature fruit. 2nd row fruit are in steady degradation process and the last row includes the fruit which farmer can't harvest and they pass to the winter season, when the plant exhibit dormancy and the fruit will become black and hard.

Benassi *et al*. (2003) [3] at Brazil studied the "Shelf life of Custard apple treated with
1-Methylcicloprοpene-An antagonist to ethylene action". He has taken Agrofresh as the commercial anti ethylene chemical containing 0.14% a.i. {0.00016 g of Agrofresh= 100 nL L^{-1} of MCP, 1 ppm = 1000 nL & 1 ppm= 1 mg/1L.}. He observed that fruits treated with 810 nL L^{-1} of MCP shows higher fruit firmness during a 4 days period at 25 °C. Mostly during the ripening process the evolution of ethylene makes the fruit soft due to the catabolic activity which, break down the cell wall polysaccharide due to the polygalactonurase and cellulse activity. But after treating the fruit with anti-ethylene chemicals the degradation of cell wall decreases hence increasing the fruit firmness to a considerable amount thus increasing the shelf-life. He also obtained lesser ripe fruit percentage with 270 and 810 nL L^{-1} of MCP due to anti ethylene activity.

Kumar *et al*. (2016) [7] have conducted an experiment on "Effect of pre-harvest application of plant growth regulators and packaging materials on shelf-life of custard apple (*Annona squamosa* L.)" by three growth regulators namely GA_3 (40 and 50 ppm), NAA (20 and 30 ppm) and 2, 4-D (10 and 20 ppm) which are applied 1 week prior to harvesting and the fruits are packed in different packaging materials (Bamboo basket, Corrugated boxes and Plastic crates). The Physicochemical observations were recorded on 0th, 2nd, 4th, 6th and 8th day during storage. Pre-harvest application of 2,4-D 20 ppm and fruits packed in corrugated boxes recorded higher shelf-life and retained better quality of fruit (maximum firmness TSS, ascorbic acid, pH and total sugar, reducing sugar and non-reducing sugar, low acidity and minimum PLW).

Fig 1: Floral structures of Custard apple

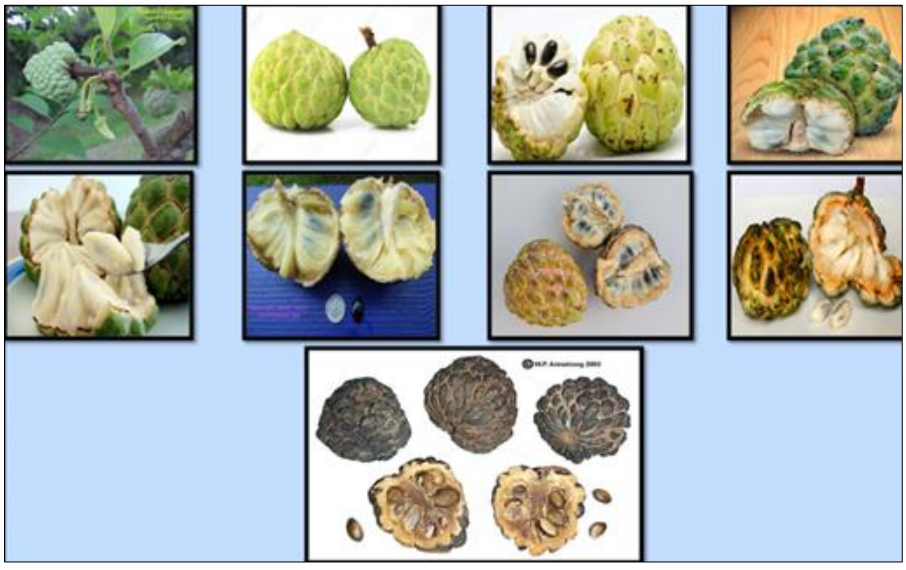

Fig 2: Stages of fruit growth in Custard apple

Conclusion

The cumulative findings from multiple studies indicate that the judicious application of PGRs can significantly benefit custard apple growers and the fruit industry as a whole. PGRs have been shown to enhance custard apple yield at GA3 @ 75 ppm (75 mg/l of water) and two foliar applications (at full bloom and fruit set stage), through improved flowering, fruit setting, and reduced premature fruit drop. This increase in productivity is crucial for meeting the growing demand for this delectable tropical fruit. Furthermore, PGRs have a direct impact on fruit quality, at GA_3 @ 1000 ppm (1 g/l of water) along with hand pollination before flowering or GA_3 25 ppm (25 mg/l of water) + NAA 10 ppm (10 mg/l of water) twice at flowering and fruit set (1 month after 1st) or GA_3 100 ppm (100 mg/l of water) twice at flowering and fruit set leading to larger fruit sizes, increased fruit weight, and improved sugar content. These quality enhancements not only satisfy consumer preferences but also improve the marketability of custard apples, potentially commanding higher prices in the market. Perhaps one of the most significant advantages of PGR use in custard apple cultivation is the extension of fruit shelf life. PGR-treated fruits such as 2, 4-D 20 ppm (20 mg/l of water) and fruits packed in corrugated boxes were less susceptible to physiological disorders, such as fruit rot and shriveling, thereby maintaining their quality and freshness for an extended period. This prolonged shelf life not only reduces post-harvest losses for growers but also ensures consumers can enjoy high-quality custard apples for a more extended duration. In addition to the agronomic benefits, PGRs offer environmentally friendly solutions by reducing the need for excessive chemical treatments and minimizing water usage. This is a notable advantage in the context of sustainable agriculture and responsible resource management. Furthermore, PGRs can result in cost savings for custard apple growers, making custard apple cultivation more economically viable. While the existing literature is largely positive about the impact of PGRs on custard apple crops, it is essential to acknowledge the need for ongoing research to optimize PGR application methods, dosage, and timing for different custard apple cultivars and growing conditions. Additionally, further investigations into the specific mechanisms by which PGRs influence custard apple plants are necessary to unlock the full potential of PGRs in custard apple cultivation. In sum, the evidence from this review strongly suggests that the controlled use of PGRs holds great promise for custard apple growers and the fruit industry, offering the potential for increased productivity, improved fruit quality, sustainable practices, and economic benefits. Continued research and practical application of PGRs in custard apple farming will be instrumental in realizing these advantages and further elevating the position of custard apple as a desirable and profitable crop.

References

1. AOAC. Official methods of analysis, 16th edn, Association of Official Analytical Chemists, Washington; c1999.
2. APEDA Agri Exchange; c2019-20. http://apeda.in/agriexchange/India%20production/India_Productions.aspx?cat=fruit&hscode=1044
3. Benassi G, Correa GASF, Kluge RA, Jacomino AP. Shelf life of Custard apple treated with 1- Methylcyclopropene-An antagonist to ethylene action. Brazilian Achieves of Biology and Technology. 2003;46(1):115-119.
4. Brand-Miller J, Foster-Powell F, Colaguira S. The New Glucose Revolution. Publisher: Headline; c2003. ISBN: 9780733616440.
5. Chaudhari JC, Yadav L, Varu DK. Effect of plant growth regulators on quality of Custard apple (*Annona squamosa* L.) CV. Sindhan. International Journal of Chemical Studies. 2017;5(5):1036-1037.
6. George AP. Custard Apple - The New Super Fruit of The 21st Century; c2018. https://www.industry.custardapple.com.au/Info-Pages/custard-apple-the-new-super-fruit-of-the-21st-century/1.0-Health-Trends.html
7. Kumar S, Kaushik RA, Rathore RS, Sarolia DK. Effect of pre-harvest application of plant growth regulators and packaging materials on shelf-life of custard apple (*Annona squamosa* L.). Green Farming. 2016;7(6):1460-1464.
8. Mahorkar KD, Naglot UM, Navsare RI, Chavhan PM. Effect of plant growth regulators on flowering, fruit set and yield of custard apple (*Annona squamosa* L.). International Journal of Chemical Studies. 2018;6(4):2381-2384.
9. Mahorkar KD. Effect of plant growth regulators on flowering, fruit set, yield and quality of custard apple [*Annona squamosa* L.] M.Sc. Thesis, VNMKV, Maharashtra; c2017.
10. Ranganna GS. Manual of analysis of fruit and vegetable products. Tata Mc Graw Hill publishing company, Ltd. New Delhi; c1977. p. 12-15
11. Shivakumar AP, Venkata Rao MK, Honnabyraiah T, Sakthivel SV, Patil KR, Vasudeva J, *et al*. Effect of Gibberellic Acid and Assisted Pollination on Fruit Characters of Custard Apple cv. Arka Sahan. Int. J Curr. Microbiol. App. Sci. 2018;7(08):2543-2549.
12. Thakur DR, Singh RN, Pomological description and classification of some annona. Indian J Hort. 1967;24:11-19.
13. Thorat UK, Dheware RM, Jadhav AR. Influence of Growth Regulators on Quality and Fruit Attributes of Custard Apple (*Annona squamosa* L.) Cv. Balanagar. International Journal of Ecnomic Plants. 2018;5(3):151-153.