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Role of Gibberellic Acid in Fruit Set, Yield and Quality Improvement of Custard Apple (*Annona squamosa* L.)

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Custard apple (*Annona squamosa* L.) belonging to the Annonaceae family, is believed to be originated in tropical America. It is popularly known as sugar apple (due to its pulp that's sweet and similar to the consistency of custard) or soursop (due to its slightly acidic taste when ripe). This fruit looks nutritious and remarkably important candidate for good health management. It contains 73.50% moisture, 23.90% carbohydrates, 1.60% protein, 1.00% iron, 0.30% fat, 0.40% phosphorous and 0.20% calcium. It is also preferred as high calorie fruit (105/100g) (Bal, 1997). It is an aggregate fruit that grows from a single flower with numerous pistils, each with one carpel. Each pistil gives rise to a fruitlet. The fruitlets are referred to collectively as an aggregate or an etaerio (Fig 1 is showing Arka Sahan, a popular variety of custard apple). Fruits are the true representatives of matured polycarpellary apocarpous gynoecium.

Fig 1: Custard apple variety "Arka Sahan", developed from IIHR, Bangalore

Custard apple derivatives offer medicinal advantages. The leaves having significant therapeutic value are amply used to treat several diseases, ulcers and grain pests, while the root is a powerful purgative. Furthermore, custard apple seed oil and seed extract having insecticidal properties are significantly used in insect pest control. Custard apple extracts have also been reported to show antioxidative, anti-inflammatory, and analgesic properties (Chavan *et al.*, 2010).

In spite of having endeavoring potential in horticulture as well as medicinal aspects, farming of custard apple faces severe yield issues due to faulty fruit set. Overall productions get down massively because of improper fertilization. In this scenario, exogenous application of gibberellic acid has been reported beneficial for enhancing the yield and quality of custard apple (Hayes, 1957).

1. Mode of Action of Gibberellic Acid

Gibberellic acids (GA_3) are naturally occurring substances which tend to control several metabolic processes in the plant. They play significant role in enhancement of fruit development, quality and production. Gender expression and the delaying of senescence in leaves and fruit are also elicited by GAs.

In many dwarf types, GA_3 seems to work around the genetic constraints. Gibberellins cause the seeds of plants that need exposure to cold or light to germinate to emerge from dormancy, which is a condition of limited growth and development. In some cases, seeds require water to start germination before they begin to grow. Water infiltration activates gibberellins, which eventually ennoble α-amylase, an enzyme that converts starches into simple sugars (Fig 2). Gibberellins encourage cell elongation in immature roots during germination. In contrary, abscisic acid, a hormone that suppresses gibberellin activity, prevents germination in this route when water is not present.

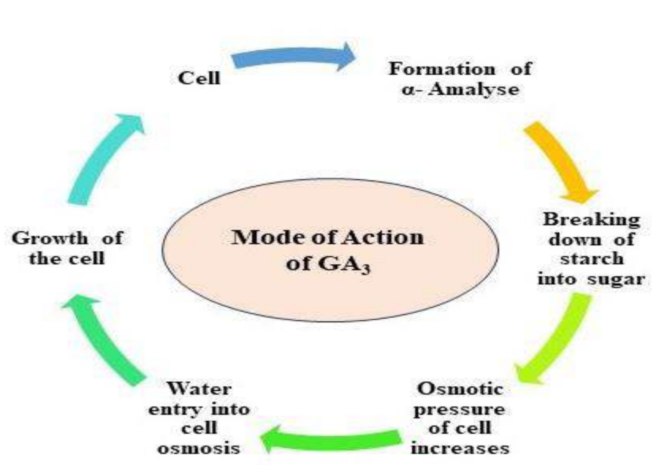

Fig 2: Mode of Action of Gibberellic Acid

Gibberellins and abscisic acid therefore work counter to one another to control the germination response.

2. Effects of GA_3 Application on Fruit Quality in Custard Apple

GA_3 remarkably improves the fruit set, fruit retention, fruit weight, pulp: seed ratio, pulp percentage, fruit diameter and length, leading to fruit yield enhancement.

(a) Fruit Set

The fruit set is derived from the amount of total flower that was turned into a well-formed, healthy fruit, and gibberellic acid improves the fruit set, helping to enhance the yield and quality of fruits. After successful pollination and fertilization, the ovary of the flower is developed into fruit, resulting increasing the fruit set. Gibberellic acid successfully replaces the fertilization process in flowers and induces parthenocarpy in fruit crops.

(b) Flower induction and inhibition

Gibberellic acid possesses vital importance in flower induction and blooming inhibition. GA_3 hinders the production of flowers as long as the sepals have not formed. However, during vernalization, gibberellic acid serves as a florigen and mostly responsible for inducing flowering in fruit crops, despite the fact that the inhibitory impact of gibberellins is more noticeable than flower induction. GA_3 have the ability to substitute for the environmental factors that favor flowering induction, and they are mostly utilized for initiating flowering in long-day plants (King *et al.*, 2006).

(c) Fruit length and diameter

Gibberellic acid enhances fruit size due to cell division, cell elongation, and expansion of vesicles, and loosened the cell wall resulting from increased plasticity. It was found that the increase in fruit size in custard apples in response to growth regulator application including which gibberellic acid may reflect their potential to drive glucose translocation to the fruit in conjunction with their influence on enhancing cell wall flexibility and fruit length.

(d) Fruit weight

Fruit weight is an important yield-contributing feature that would increasing the yield per unit area and consequently increase profit. So, the fruit weight enhancing due to the external supply of gibberellic acid directly responsible for the fruit weight as it promotes cell division and cell elongation. The foliar application of growth regulators encourages cell proliferation and enlargement, encourages active polar transport, and increases the storage of food resources like carbohydrates and water in enlarged cells.

(e) Fruit yield

Fruit yield generally depends on the weight of the fruit and the number of fruits per tree. This is called overall fruit development, which means the process of the cells enlarging to produce a larger fruit once the fruit has been successfully hung on the tree. Gibberellins work best when applied during the phases of fruit development because they boost fruit size and yield. Applying gibberellins 20 to 30 days before harvest results in larger, firmer cherry fruits because gibberellic acid stimulates cell enlargement and cell division, increasing the quantity and size of fruits, resulting in increased fruit production and fruit weight (Looney and Lidster, 1980).

(f) Pulp: seed ratio

GA_3 helps to increase the pulp ratio due to cell division and cell elongation and it will also play an important role in reducing seed number in the fruit when applied after fertilization.

3. Effects of GA_3 Application on Biochemical Aspects in Custard Apple

Gibberellic acid stimulates the flowering, development, and growth of the fruit, resulting in extreme fruit quality. It improves several biochemical parameters, *i.e.,* total soluble solids (˚B), reducing sugar, titratable acidity, total sugar, ascorbic acid, *etc*. GA_3 increases in total soluble solid (˚B) may be due to the quick metabolic conversion of pectin and starch into soluble molecules and the speedy translocation of sugars from leaves to fruits. Furthermore, it boosts up the transfer of metabolites from other areas of the plant to growing fruits, resulting the activity of enzymes like amylases, which hydrolyze complex polysaccharides into simple sugars, may be increased. Eventually, cellular levels of ascorbic acid get increased throughout the growth and development of fruits. In addition, The gibberellic acid that positive influence on custard apple acidity. The acidity decreases with the increasing in the concentration gibberellic acid. This may be due to metabolic alterations that include the rapid conversion of organic acids into sugars and their derivatives through processes involving the reversal of the glycolytic pathway or respiration.

Conclusion

Custard apple is a delicious fruit, used for processing and medicinal purpose but the farming of custard apple faces severe yield issues due to faulty fruit set. Overall productions get down massively because of improper fertilization. In this scenario, exogenous application of gibberellic acid is believed to be beneficial for enhancing the yield and quality of custard apple and helps to better income for farmers and maintaining the living of standard.

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