



Studies on Gibberellic Acid (GA₃) and Cycocel (CCC) on Plant Growth Yield and Quality of Strawberry

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Strawberry is soft, luscious, nutritious, tasty, and perishable fruit which are grown in temperate climatic conditions where the plant behaves like a small perennial herb and also grown in a sub-tropical climate whose plant behaves as an annual belonging to the family Rosaceae (Salentijn et al., 2003; Srivastav et al., 2018; Cv et al., 2016). The cultivated strawberry (*Fragaria ananassa* Duch.) is a monoecious octaploid hybrid of two largely dioecious, octaploid species, *Fragaria chiloensis* Duch. and *Fragaria virginiana* Duch (Cv et al., 2016). Strawberry is a non-climacteric fruit and characterized by a high softening rate, short post-harvest life, and fast decay (Bustamante et al., 2009). Strawberry (*Fragaria * ananassa*) is a short day plant that has antioxidant, anti-inflammatory, anti-neurodegenerative and anti-cancer component called ellagic acid, contain phenolics and flavonoids and also rich in vitamins, minerals like potassium, phosphorus, calcium, and iron (Roussos et al., 2009). It is propagated through the runners and is red in colour due to the presence of anthocyanin, peltarogonidin, 3-monoglucoside, and traces of cyanide (Srivastav et al., 2018). Consumption of strawberries leads to health benefits against cancer, aging, inflammation, and neurological diseases (Cv et al., 2016). Camarosa, Laguna, Seascape Chandler, Sweet Charlie, Fern, Douglas, Redgauntlet, Talisman, Cambridge Favourite, Domanil, Fanil, Gorella, Goupil, Senga gigana, Senga precosana, Surprise des Hailes are different cultivars of strawberry (Sharma and Singh, 2009; Paroussi et al., 2002; (Tehranifar and Battey, 1997) Terms, 2017). Strawberry's edible parts are receptacle, petioles, achenes or real fruit, and seed. It has short stems known as crown which produces leaves along the stem axis and flowers (Srivastav et al., 2018) (Figure 1). Different plant growth regulators perform different function on strawberry. Various PGR like Auxin, gibberellin and cytokinin are used in strawberry in order to increase the fruit size, enhance fruit set, growth, and yields. Among them, auxin are used for enlargement of receptacle, fruit size growth and delay fruit ripening, gibberellin inhibit the fruit ripening, abscisic acid develop a color on fruit and nitric oxide extent the post-harvest life of ripe fruit (Roussos et al., 2009; Marcos et al., 2009)

Botanical Classification of Strawberry

Scientific name is *fragaria x ananassa*, it belongs to family rosaceace, family plantae, division magnoliophyte, class magnoliopsida, order rosales and sub family rosoideae.

Fragaria are low herbaceous perennial plants that have compound leaves with three hairy, sawtooth edged leaflets. The flowers are white and grow in clusters on thin stalks. In addition to the seeds produced by these flowering plants, strawberries spread by stolons as they get older.

The fleshy, edible strawberry "fruit" is technically not a single fruit nor a berry. It is an accessory fruit; that is, the fleshy part is derived not from the ovaries, which yield the "seeds" (actually achenes), but from the peg at the bottom of the hypanthium that held the

ovaries. (The hypanthium is the bowl-shaped part of a flower consisting of the bottoms of the sepals, petals, and stamens stuck together). So from a technical standpoint, the seeds are the actual fruits of the plant, and the flesh of the strawberry is modified receptacle tissue, which contains numerous partially embedded fruits (seeds). It is whitish-green as it develops and in most species turns red when ripe.

Origin

The cultivated large-fruited strawberry (*Fragaria × ananassa*) originated in Europe in the 18th century. Most countries developed their own varieties during the 19th century, and those are often specially suitable for the climate, day length, altitude, or type of production required in a particular region.

Economic significance of strawberry

Strawberry (*Fragaria × ananassa* Duch.) is an important commercial fruit crop with rich organoleptic qualities such as a pleasant flavor, texture, and taste, and numerous health benefits. Strawberries are widely consumed as fresh fruit or processed into various food products.

Influence of gibberellin on strawberry

Plant heights, number of runners, number of flowers, fruit set percentage, number of fruits, fruit size, fruit weight, and fruit quality are all affected by gibberellic acid (Kumra et al., 2018) Gibberellic acid (GA3) treatment promoted flowering in non-chilled strawberry plants, shortened the cropping season, and increased vegetative growth and fruit number (Paroussi et al., 2002). It acts as a fruit ripening inhibitor (Marcos et al., 2009). It Increases vegetative development, increases runner formation, lengthens the main stem internode, initiates flower development, promotes stolon formation, petiole length, and leaf area, destroys rosette habit, and slows blossom initiation (Sharma and Singh, 2009; Guttridge and Thompson, 1964; Tafazoli & Vince-prue, 2015). The effects of a long photoperiod or chilling are also caused by GA3 (Guttridge, 1970). Gibberellins are well-known for acting as a long-day hormone in short-day plants. Gibberellin treatment increases vegetative growth but limits flower development (Kender et al., 1971). The GA 3-oxidase enzyme prevents runner and crown branch development, increasing berry output (Hytonen, Elomaa, Moritz and Junttila, 2009). By hydrolyzing protein and releasing tryptophan, GA promotes pollen germination, pollen tube expansion, and auxin biosynthesis. GA3 boosts diphenols while inhibiting IAA oxidase activity, resulting in a high auxin level. In the absence of fertilizer, the use of GA resulted in fruit set

Influence of chlormequat(chlormequat)

Plant growth regulators are broadly utilized in fruit crops harvests to advance vegetative development, blossoming, and fruit improvement. Plant development controllers have been found to indirectly affect sprouting by lessening the vegetative turn of events (Islam and Mohammad, 2020; Kumra and Reena, 2018). CCC (Chlormequat), the first plant growth regulator was discovered by professor Tolbert at Michigan state university in the 1950s which is a synthetic PGR antagonist to GAs. number of leaves, and leaf region were completely decreased. Besides, GA3 125 ppm treated strawberry plants had the most extreme plant stature (24.13 cm), while treatment T10 (GA3 75 ppm þ CCC 500 ppm) treated strawberry plants had the most elevated length measurement proportion of fruits (2.10). As per the aftereffects of the test directed by Altintas (2011), favorable to Calcium (Ca) has a restraining impact on stem stretching with no adverse consequence on absolute and early yields and fruit quality for quite a long time; furthermore, with 100, and 300 mg l⁻¹ supportive of Calcium applications presenting a benefit over control plants, they would be adequate to control stem prolongation. Crops grown with chlormequat chloride have shorter

internodes but thicker, darker leaves and the chemical control of plant growth to reduce size through the use of PGR is a common practice to make plant more compact and commercially acceptable (Kumra et al., 2018). High NPK increased both leaf area and adjusted leaf area with CCC treated plants benefitting more than PP333 treated plants (McArthur and Eaton, 1988). In Europe cereal production chlormequat chloride was the first PGR to be used on large scale as antilodging agent. Similarly, chlormequat chloride applied in winter wheat at early stage of tillering increases the number of fertile tillers also reducing length of stem (Rademacher, 2015). Strawberry vegetative growth has been found to be aided by GA3 and the use of cycocel increased strawberry yield and quality. The use of cycocel at 500ppm increased the number of flowers, fruit per plant and yield.

Physiological disorders of strawberry

Albinism (lack of fruit colour during ripening) is a physiological disorder in strawberry. It is probably caused by certain climatic conditions and extremes in nutrition. Fruits remain irregularly pink or even totally white and sometimes swollen. They have acid taste and become less firm.

Harvesting

Strawberries can be consumed fresh or preserved by freezing or dehydrating and canning. Harvesting is generally practiced after 3–4 months from planting. Strawberries are the sweetest when they are fully ripened on the plant. It is better to leave them on the plant for a day or two till they turn red. To ensure ripeness, taste test can be made. During harvesting berries, care should be taken as ripe ones bruise very easily. For harvesting, snap the stem just above the berry to remove them from the plant. Store harvested berries out of direct sunlight in some cool place, such as a refrigerator immediately after picking to increase the storage time.

Conclusion

Plant growth regulators are the tools in flowering, fruiting, and ripening. The use of PGRs is increasing day by day mainly in many agricultural fruit crops. Therefore, numbers of synthetic chemicals are used for the regulations of growth and development of cultivated plants. Moreover, these growth regulators can be utilized for sustainable and ecologically sound fruit production. In addition, promote the less use of chemical fertilizers to a great extent. The review focuses on the influence of PGRs on growth, yield, and fruit quality of fruit crops.

References

1. Ali, A., Kumar, A., Rasool, K., Ganai, N.A., Lone, A., Baba, T.R., Hamid, M., Haq, A., 2021. Triacantanol spray mediated plant growth and productivity in fruits crops : a review.
2. The Pharma Innov. J. 10 (7), 789–792. Altintas, S., 2011. Effects of chlormequat chloride and different rates of prohexadionecalcium on seedling growth , flowering , fruit development and yield of tomato
3. Afr. J. Biotechnol. 10 (75), 17160–17169. Archbold, D.D., Dennis, F.G., 1985. Strawberry receptacle growth and endogenous IAA content as affected by growth regulator application and achene removal.
4. J. Amer. Soc. Hort. Sci. 110, 816–820. Babalar, M., Asghari, M., 2007. Effect of pre- and postharvest salicylic acid treatment on ethylene production , fungal decay and overall quality of Selva strawberry fruit.
5. Food Chem. 105, 449–453. Bakshi, M., 2018. Influence of PGRs on growth, yield and quality of strawberry under U.P subtropics.