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Impacts of Plant Growth Regulators on Strawberry Plant

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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, pelarogonidin, 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 is rich in Vitamin A (60 IU/100 g of edible portion), vitamin C (30–120 mg/100 g of edible portion), fiber, pectin (0.55%) and has a low calorie carbohydrate content and is high in carotenoids, flavonoids, phenols, and glutathione (Sharma and Negi, 2019; Nautiyal and Shukla, 2015).

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).

Influence of auxin (NAA) and tricontanol on growth yield and quality

NAA is a synthetic auxin that is most commonly employed in the production of high-quality strawberries in terms of total sugars, ascorbic acid content, and titrable acidity percentage (Bhople et al., 2020). NAA is a synthetic version of auxin that aids in cell elongation,

division, vascular tissue differentiation, root initiation, apical dominance, leaf senescence, leaf and fruit abscission, fruit setting ratio, fruit dropping prevention, and flower sex ratio promotion (Mehraj et al., 2015). Naphthalene acetic acid is one of auxin's most important members, and early application of Napthalene acetamide in early stages induces cell division in cambium cells, resulting in the production of xylem tissue in lower internodes, which provides mechanical support to plants while also preventing lodging (Thakur et al., 2017). It has been reported that a medium containing a low concentration of NAA 0.1 mg/l and a relatively high concentration of BA 1.0 mg/l is best for shoot generation, and that a medium containing a high concentration of cytokinin and a low concentration of auxin (a medium with a cytokinin to auxin ratio greater than 1) is best for shoot bud induction. (Lal et al., 2003). Auxins such as IBA (Indol-3-butyric acid) and NAA (Naphthyl acetic acid) are used to promote rapid and abundant rooting of cuttings from a variety of trees, vines, shrubs, annual and perennial ornamentals (Rademacher, 2015). The effect of NAA on plant growth is greatly reliant on the time and concentration of entry, as well as promoting cellulose production and limiting fruit drop (Suman et al., 2017). Plants treated with tricontanol increased root number causing plant to absorb more nutrients from the soil and increased production per plant and similarly the tricontanol treated strawberry had the highest number of fruit, yield per hectare and B:C ratio (Khunte, Kumar, Ansari, et al., 2019) TRIA has been shown in several studies to play an important role in regulating a wide range of plant morphological responses, including increasing plant height, biomass, leaf number, and leaf area per plant in most harvests. Foliar application of TRIA up to 1 ppm also resulted in twice the fresh and dry weight of shoot and root of Solanum lycopersicon (Roberts and Hooley, 1988). Triacontanol, Activol (GA3, a plant growth regulator), and NAA all increased strawberry vegetative development compared to the control.

Influence of 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. The CCC has been shown in studies to efffectively reduce the growth of potato stems, leaves, and runners and thicken the stem of mung bean by controlling vein growth and lodging. Dwarfed plants, thickened stalks, increased chorophyll contents and well developed root systems are results of CCC application (Liu et al., 2019). Likewise, as indicated by Tiwari et al. (2017) and Zaid et al. (2020a,b), foliar sprays of (GA3 at 200 ppm) at 30, 60, 90, and 120 days after relocating were deemed the best plant development controllers (PGR's) in terms of vegetative development limits, while (GA3 at 150 ppm) was deemed the best in terms of fruit quality for strawberry development. As per Kumra and Reena (2018), strawberry plants treated with cycocel in September and additionally October yielded before and to some degree more prominent yields in three-year preliminaries.

Effect of plant growth regulators on quality of strawberry

The physical and chemical features of the strawberry fruit are modified by the use of growth regulators. The use of plant growth regulators improves the quality of strawberry fruits, according to several studies. All doses of GA3 improves strawberry vegetative development, but cycocel at 500 ppm, followed by NAA at 30 ppm, is the best in terms of strawberry output and quality (Bakshi, 2018; Sood et al., 2022). In strawberries, skin hardness is connected to the production of hard achenes, and auxin is known to control this process, resulting in the hardiest fruit in NAA-treated plants. The use of NAA in strawberry plants

raises the TSS level by increasing the concentration of volatile compounds as well as the hydrolysis of starchy compounds (Rathod et al., 2021; Saima et al., 2014; Thakur et al., 2017). Likewise, Strawberry is also quite susceptible to salt, and it has been noted that the quality of strawberry fruit has decreased. strawberry fruits had the highest TSS and sugar content. Similarly, Nautiyal & Shukla (2015) claimed that the use of nitrogen-fixing bacteria and GA3 with a lower nitrogen dosage may have a regulatory effect on the absorption and translocation of several metabolites, the most significant of which is carbohydrates, which influences the quality of fruits.

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.

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