Effect of photoperiod and gibberellic acid (GA₃) on flowering and fruiting of strawberry - A review

Kanchan Rana, Nidhi Chauhan and Jyoti Bharti Sharma

DOI: https://doi.org/10.22271/phyto.2020.v9.i6x.13185

Abstract
The use of plant growth regulators is exceptionally common practice in present day cultivation. They give a few benefits rearranging and improving fruit production. In commercial production of strawberry, the most development controller utilized and researched is GA₃ for the most part altering the beneficial characteristics of plants. Such as increasing fruit weight, plant height, early flowering, petiole length, fruit set, leaf area, yield and improve quality of fruit and also help in stem elongation and cell division. Photoperiodism plays an essential role in flower initiation. The photoperiod promoted plant growth, but also enhanced runner growth, runner formation and ramet growth. It could encourage a stronger runner plant to multiply. The light irradiation during the nursery season accelerated the harvest due to the ongoing flowering.

Keywords: strawberry, flower, photo period, gibberellic acid, fruit

Introduction
The gibberellins were discovered by Japanese scientist, who studied the foolish rice disease caused by fungus Gibberella fujikuroi (asexual stage) in 1920. Later on, the active substance, which was quite heat static, was isolated from the fungus and named as gibberellin by Teijiro Yabuta in 1935. Further work on gibberellins led to the identification, synthesis and crystallization of gibberellic acid in 1950s (Brian and Hemming, 1955). Gibberellic acid (GA₃) is a phytohormone, which is naturally present in plants in very small amounts. So for good growth, development and for more yield of plant, exogenous applications of gibberellins have proved to be beneficial for the crops. The commercial product of gibberellic acid is synthesized artificially which is available in various forms but mainly in liquid form for exogenous sprays. Gibberellic acid helps to improve the fruits in many different ways such as, it increases fruit marketable demand. All known gibberellins are diterpenoic acids, synthesised in plastids via the terpenoid route and then modified in the endoplasmic reticulum and cytosol until they enter their biologically active form. All gibberellins come from the ent-Gibberellin framework, but are synthesized by ent-Kauren. Gibberellins have two groups based on the existence of 19 or 20 carbon atoms. But only few GAs are bioactive while others are deactivated. Bioactive GAs occurs both in the fungi and bacteria and consists GA₁, GA₂, GA₃, GA₄, GA₅, which are used in all over the world. There are three common structural features among these Gas viz. hydroxyl group, carboxyl group and the lactone ring. GA₃ and GA₆ are examples of bioactive Gas but do not have a hydroxyl group. The presence of GA₃ in several plant species suggests that, this is a common bioactive GA. The physiological response of species to the length of the day or night is termed as photoperiodism. Photoperiods and light quality have profound impacts on the flowering in strawberries, while the intensity of light has a lower influence. Strawberries are categorized according to their photoperiodic flowering responses: short day, long day and day-neutral. June bearing plants are ever bearing plants, initiate flower buds under short day and long day respectively. In day-neutral plants, flower induction is relatively in different day duration. Others, however, consider true day-neutral genotypes distinct from the other classes genetically and physiologically (Ahmadi et al., 1990). Most researchers accept that, due to the spectrum of photoperiodic responses found in various genotypes, categorization is difficult. The photoperiodic response is quantitative and, for cultivars within a class, the response curve varies. When the photoperiod is less than 14 h, SD genotypes initiate flowers, whereas LD genotypes typically require photoperiods greater than 12 h (Darrow 1936). Photoperiod and light quality help to increase the plant growth, flower initiation and increase leaf area.
Effect of gibberellic acid (GA₃) on the growth and development of strawberries

Gibberellins have been shown to affect the growth and development in strawberry to a greater extent. In a study conducted to evaluate the influence of plant growth regulators on strawberry cv. Chandler, GA₃, IAA and NAA (25, 50 and 100ppm, respectively) were applied in triplicate. Application of these growth regulators resulted in enhancement of the vegetative characters in strawberry. However, for vegetative characters including runner production, GA was found to be the most responsive among other plant growth regulators. NAA @ 100 ppm was effective in alleviating the yield characters in strawberry (Suvalaxmi et al., 2016). Gibberellic acid results in higher cell division which enhances the vegetative growth in plants. In strawberry, GA₃ diminishes blooming and as a result vegetative development counting generation of runners increases (Arteca, 1995) [33].

Plant growth regulators viz. BAP, GA₃ & Kn in different composition produced different crave response in vitro. The treatment [BAP (1.5mg/l) + Kn (0.1mg/l)] given after 30 days of culture, gave the highest number of shoot (3) with 5.5cm shoot length, highest number of leaves (7) and maximum survival rate of explants (70%-75%) and thus it was found to be the best among the various treatment combination (Bhat et al. 2012) [3].

Effect of gibberellic acid (GA₃) on the flowering and fruiting of different strawberry cultivars

Ozgüven and Yılmaz, (2000) [41] examined the effect of GA₃ on the flowering and fruiting of strawberry and determined that GA₃ caused the early blossoming and fruiting of cv. Camarosa, particularly at 10 ppm and 20 ppm doses but in low freezing temperature, the effectiveness of the treatments on fruit yield was failed. Similarly, Thakur et al., (2017) [56] disclosed that treatment of strawberries with 15 ppm GA₃ + GA₃ applied two weeks before blooming, increased the flowering, fruit diameter, fruit set, fruit length, fruit weight and yield while, promalin gave best results at 6 ppm concentration with increased yield (137.92%) and fruit weight (51.81%).

Narayan, (2014) [37] analysed that two foliar sprays of 100 ppm GA₃ at one month after planting and 15 days after flowering gave the highest value of leaf numbers, crown per plant, plant height and runners per plant in the strawberry cv. Chandler.

Effect of photoperiodism on the growth, development and flowering of the strawberry varieties

Strawberry plants act as donor or receptor units. The effect of long photoperiods or a light-break treatment increased petiole length, leaf size and the flower initiation in the donor plants and short photoperiod treatment delayed flower initiation in receptor plants (Guttridge, 1956) [17]. Wu et al., (2009) [58], described that, LED was found to be the best light source for runner generation. Similarly, Yoshida et al., (2016) [61] observed that blue light from the different peak LED type encouraged more blooming as compared to red light as well the photosynthetic pace under the blue light was higher than under the red light. Likewise, Hidaka et al., (2013) [25] reported that the leaf photosynthesis was altogether higher in plants illuminated with tall irradiance LEDs than in those lighted with fluorescent lights. As a result, supplemental lighting (more 12h per day) given by LEDs driven to superior in the fruit quality and higher marketable value of strawberry fruits.

The photoperiod from 11 to 17 h increased flower bud induction by 2-, 5-, and 20-fold in three different long day (LD) cultivars while, floral induction in day-neutral (DN) genotypes occurs independently of day length (Downs and Piringer, 1955) [40]. The minimum number of photo inductive cycles required for flower bud induction in strawberry ranges from 7 to 24 (Hartmann, 1947; Heide, 1977; Hancock, 1999) [19, 22, 43]. The photoperiodic response of flower bud induction in strawberry is well described in terms of day length, little is known regarding the effect of quality. The far-red extension delayed induction but red light increased the flower induction in strawberry (Zahavi and Ephrat, 1974; Guttridge, 1985) [62, 67].

The Frigo plant of ‘Elkat’ strawberries were examined, beneath diverse light-emitting diode treatment: (red and a combination of red and blue LEDs). Results revealed that, red LED initiated prolongation of flowering stem and entire plant; this brought about in higher shoot/root proportion whereas, a blend of red & blue LED spectral components is fundamental for the improvement of Frigo strawberries (Samuoliene et al., 2010) [50] GA₃ and photoperiod regimes, long and short days, using 16 hours and 10 hours light respectively were applied in different quantity in different varieties of the strawberry. As a result, the leaf area and the length of the petiole were increased by GA₃. Application of GA₃ at high concentration (200mg/l) increased the petiole concentration duration to a greater degree (50mg/l) than at a lower concentration. The leaf increased with the distinct GA₃ application dose to a similar extent, region (Paroussi et al., 2002) [44].

Effect of GA₃ on quality parameters

Paroles et al., (2018) [42] described that the application of plant growth regulators (RDF + 75 ppm GA₃) was expected to be the best way to increase the quality parameters, i.e. TSS: acid ratio, total sugar, reduction of sugar, non-reducing sugar and the content of ascorbic acid, compared to control, while fruit acidity decreased with the same treatment.

Effect of GA₃ on ripening of strawberry

Gibberellin sprays can be used to increase the amount of fruit picked during the picking season. An analysis of the effect of this compound on ‘Sparkle strawberry suggested that gibberellins at a concentration of 10 ppm should be applied three times at weekly intervals beginning in the autumn when the flowers are first launched for better performance (Smith et al., 1961).

Effect of GA₃ on strawberry disorders

Experiments have been conducted to study the impacts of foliar application of gibberellic acid on vegetative development, flowering, fruiting and disorders of the ‘Chandler’ strawberry. Results indicated that application of GA₃ @ 75 ppm improved vegetative and reproductive growth of strawberries with a lower proportion of malformed and button berries with higher marketable fruit yields, and without any adverse effects on fruit quality (Sharma and Singh, 2018) [51].

Effect of GA₃ on ripening of Strawberry

The effect of GA₃ was evaluated by different biochemical parameters on post-harvest maturation in strawberry fruit. Strawberry slices were incubated with GA₃ at various ripening levels. Studies suggested that GA₃ has an inhibitory effect on the maturation of strawberry fruits, evidenced by
decreased respiratory activity and delayed synthesis of anthocyanin and degradation of chlorophylls (Martínez et al., 1994).

Conclusion
GA₃, photoperiod and essential elements are vital components of plant (crop) life cycle affecting quality and quantity of fruits and their optimized usage can improve production, promote plant health and increase yield. The alteration in the photoperiodism (light) along with GA₃ applications found to decrease the time duration required for inflorescence initiation & bud formation as well as enhance runner growth, development, vegetative growth and yield in strawberries. Applications of growth regulators (GA₃) also help to reduce physiological disorders of strawberry to some extent but their role is quite unknown.

References


