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Review Article

IMPACT OF PLANT GROWTH REGULATORS ON REVERSAL OF REPRODUCTIVE CHARACTER IN SOME CROPS: A REVIEW

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Abstract: The Plant Growth Regulators are chemical compounds which can regulate some important metabolic activities in plants. They influence growth and development of plants which is also accompanied by increase in yield, quality of product, flowering and some other parameter. Application of PGR in different concentrations on some economically important crops proved as beneficial. Application of Ethrel, CCC and GA_3 confirm an effect on reproductive character, more specifically in their reversal from male to female. The growth retardant and promoter are equally significant in their performance in some fruit yielding crops.

Keywords: Ethrel, CCC, GA_3, Reproductive character

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Introduction

Plant Growth Regulators are substances which can manipulate growth and development in plants. Many workers from different corners of the world are now concentrating their field of works on higher productivity of agricultural and horticultural crops by using Plant Growth Regulators (PGRs). PGRs can influence plant height, leaf number, leaf area index, dry mass, chlorophyll content, photosynthetic parameters, seed yield, oil yield, nutritional status *etc.* During the last four decades or more numerous experiments have been done with the application of growth retarding chemicals. There are a lot of reports on extensive works done with conventional retardants like CCC, SADH, AMO 1618, 2, 4-DNC, Phosphon-D *etc.* but work with dikegulac is rather scanty in the literature. Bocion, Sachs, Purohit, Bhattacharjee and some others contributed variously working on this less explored retardant. The spectacular achievements in sex modification of plants have been reported from several quarters by the application of auxins. It was demonstrated that [1] the early application of IAA and NAA increased the number of female flowers of cucumber (*Cucumis sativus L.*) and pumpkin (*Cucurbita pepo*) at the expense of male flowers. In the squash plant male flowers are produced near the base and female flowers at about 20th node, but treatment with NAA induced female flowers to be formed near the 9th node. Further striking examples were presented by [2] in maize and hemp. In maize treatment with NAA during the period of inflorescence differentiation induced the formation of hermaphrodite or female flowers in the normally wholly male terminal inflorescences [3]. In the dioecious plant hemp (*Cannabis sativa*) surprisingly enough the experiment resulted in converting the male plant to female plant by treatment with NAA in lanoline [4]. The work of [5] confirmed the effect of ethrel and CCC in reversal of reproductive character in *Sechium edule* L. which lead to greater yield. They reported that ethrel at 250 µg/ml and CCC at 250 µg/ml were the best treatments for production of maximum female flower in *S.edule* L. The interaction of ethrel and CCC with growth promoter GA_3 exhibited further better result [6]. The aim of the current investigation is to find out the effect of PGRs on plants with reference to reversal of reproductive character.

Effect of PGRs on Reproductive Character

Effect of Ethrel (2-Chloroethyl Phosphonic Acid) on Reproductive Character General recognition of ethylene, a simple hydrocarbon gas (C_2H_4), as a plant hormone has come about only relatively recently, although it has been known for more than three-fourths of a century that the gas has numerous interesting effects on plant growth and development. It was suggested that 'with very sensitive instruments and very careful technique, it has become possible to show that ethylene is an endogenous growth regulator in plants [7]. Ethylene can regulate ripening, senescence, abscission, epinasty, swelling and elongation, hypertrophy, dormancy, hook closure, leaf expansion, flower induction, sex expression and exudation [8]. Ethylene is a gaseous effector with a very simple structure is patented as "Ethrel" and given the trivial name "Ethephon" the compound is 2-chloroethyl phosphonic acid (CEPA). Ethephon decomposes spontaneously in aqueous solution and in tissues to yield ethylene. The work of [9] observed that ethephon is a potentially effective ripening agent for Saskatoon fruits. The study of [10] revealed the potentiality of using ethephon as a tillering agent for Cardamom.
The influence of Ethrel on sex expression has been studied by several investigators. The work on Luffa cylindrica L. to find out the effect of Ethrel on sex expression as well as on endogenous auxin content [11]. He found that application of Ethrel caused a shift towards femaleness. Ethrel increased female flowers but hastened the appearance of the first female flowers compared to the control. The effect of Ethrel delayed the appearance of the first male flower along with increase of total number of male flower and as a result the sex ratio is decreased from 12.1:1 to 6.8:1. Application of ethrel caused a shift towards femaleness in other cucurbits also [12], [13]. Increase in female flowers in smooth gourd, snake gourd and bottle gourd due to the application of 2-chloroethyl phosphonic acid were obtained by [14]. The work of [15] revealed that ethrel 100 ppm delayed the appearance of first male and female flowers in bitter gourd (*Momordica charantia L.*). Ethrel at 100 ppm induced the first staminate and pistillate flower at the lowest node at 6.5 and 9.5 respectively. According to [15] ethrel decreased the endogenous level of auxins which may be responsible for the late induction of female flowers but produced them at the lowest nodes. The results observed by [16] that ethrel was effective in delaying the male phase in muskmelon.

Similar result was obtained by [17] in ridge gourd. Ethrel caused increased femaleness in cucurbits [18], [19]. The works of [11] on Luffa cylindrical L. showed that the plants when sprayed with ethrel increased the content of endogenous auxin remarkably , especially in the Rf region 0.3-0.5 while there was very little change in plants sprayed with water indicating femaleness induced by ethrel is due to increase in the level of endogenous auxin. Ethylene is considered as the main sex hormone in cucumber and its role in promoting femaleness is well established [20]. They explored the possible role of ethylene sensitivity in cucumber sex determination. Their data implicate ethylene perception in sex determination and support the notion that receptor levels and not only ethylene hormone levels, could be a limiting factor in bud sexual development [20]. A work was done on influence of plant growth regulators on flowering, fruit yield and quality of pumpkin by [21]. A trial was conducted on *Cucurbita moschata* L cv. local selection at Gwalior in 1995-96. Plants were sprayed at the 2 true leaf stage and again at the 3 to 4 leaf stage with 100 or 200 ppm ethrel NAA or maleic hydrazide or 25 or 50 ppm gibberellic acid. Fruit yield was highest with either concentrations of ethrel. Male flowers appeared earliest with 25 ppm gibberellic acid and female flowers with 200 ppm ethrel. The works of [22] established the fact that the sexual expression of squash is controlled by ethylene and that flower abscission is also known to be controlled by this same hormone.

Effect of CCC (2-Chloroethyl Trimethyl Ammonium Chloride) on Reproductive Character

The effect of growth retardant CCC on flowering, flower quality and yield were studied by many workers. [23] treated chrysanthemum plants with CCC at 2000 ppm and observed that they flowered more profusely. It was observed by [24] that increase in flower number in chrysanthemum by application of growth retardants. [25] investigated the effect of growth regulators on regulation of crop and fruit quality in lemon and reported that among all the growth regulators CCC increased the number of flowers per tree and decreased the length of shoot. [26] observed that sprays of CCC at 100 ppm recorded an increase in the percentage of fruit set and number of fruits per tree in kinnon mandarin. [27] worked on the effect of plant growth regulators CCC and NAA on the growth and yield of summer mungbean. They reported that CCC at 1500 ppm had a growth retarding effect. The results of their study show that application of CCC at 750 ppm or NAA at 20 or 40 ppm can be advantageously employed for increasing the grain yield of summer mungbean. [28] studied the effect of plant growth regulators on green gram (*Phaseolus radiatus*). They reported that application of CCC 750 ppm significantly increased the number of branches over the control. The effect of growth regulators on sex expression of mango were investigated by [29] and reported that cycocel (CCC) was most effective in increasing hermaphrodite flower in 'Bombai' mango resulting high sex ratio. CCC application increased the number of pods per plant in Soyabean [30], green gram [31]. [32] studied the effect of CCC and TIBA at varying concentrations in the flowering of two chrysanthemum varieties. They observed the reduction in flower number with CCC (at all the concentrations *viz*. 5000, 10000 and 15000 ppm). In contrast, [33] reported that chrysanthemum plants treated with MH and CCC showed an increase in the duration of flowering accompanied by improved yield and quality.

Effect of GA_3 (Gibberellic Acid) on Reproductive Character

During the thirties of twentieth century gibberellin was isolated and crystallized from *Gibberella fujikuri* by Japanese scientists (Yabuta and Sumiki 1938), though it was almost forgotten in the following years. Small and Small (1956, 1959) isolated a gibberellin from Phaseolus vulgaris and other plants, thus showing that these compounds are far spread in the plant kingdom. Phinney (1983) provided a more personal and anecdotal account of the history of the discovery of the GA_3 in the higher plants. Today more than 110 different gibberellin are known (GA_1 - GA_{110}) that differ only little chemically but very much in their biological activities. They are found not only in fungi but their presence has been finally established in higher plants too. It was reported by many workers that sex in flowers is genetically controlled and can be altered by exogenous application of plant growth regulators. In cases, where auxins promote femaleness, an application of GA will promote the formation of male flowers [34]. Sex expression in plants is controlled by maintaining the balance between auxins and gibberellins [35]. It was reported that application of GA_3 induced early flowering and more inflorescence per plant [36]. In *Liatris spicata* (*W. gloriosa*) GA_3 treatment reduced the time of flowering as well as increased inflorescence quality [37]. The effect of GA_3 on vegetative growth of the plant was studied extensively by various investigators. Luxuriant vegetative growths including height of the plant, the number of leaves/plant in *Trigonella foenum graucum* L were observed after the treatment of GA_3 [38]. It was reported by [39] in Coleus that the number of inflorescence/plant was more than double of the controls. The application of GA_3 and ethrel in Kew and Queen varieties of pineapple showed enhanced flowering [40]. It were studied by [41] and [42], the effect of GA_3 in flowering behaviour of pineapple and reported that GA_3 can significantly increase the flowering of pineapple with early flowering as compared to untreated control. It was observed that luxuriant vegetative growth brought about by GA_3 initially and then giving a check by growth retardants, the yield could be increased significantly.

Conclusion

It is evident that Plant Growth Regulators exhibit a positive impact on different vegetable crops, specifically those belonging to the family *cucurbitaceae*. Hence, they can be utilized commercially for enhancing productivity of such crops and thus fulfill the demand of the market. However, there is much scope to explore the effect of these phytohormones on other economic plants.

Application of review: Plant Growth Regulators application improves the quality as well as the yield in crops. This review focuses on the works of many scientists which would help agriculturists to enhance the productivity and also shows the future scope of such research.

Review Category: Plant Growth Regulators

Abbreviations:
CCC: 2-Chloroethyl Trimethyl Ammonium Chloride
GA_3: Gibberllic Acid

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