Effect of plant growth regulators on cucurbits: A review

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Abstract
Plant growth regulators are used to alter a crop by changing the rate or pattern, or both, of its response to the innate and exposed factors that govern development from seed germination to the new seed development through the various physiological as well as postharvest impact. Cucurbits are the major group of vegetables grown all over world and they are responsive crops towards the growth regulator. PGR’s play vital or key role in increase growth, yield and quality. The spray of GA3 50-100 ppm increases growth, number of male flowers and weight of fruits. Ethrel 400-500 ppm increased number of female flowers, enhanced maturity cycle and improve sex ratio by suppress the male flowers. Auxin 50-100 ppm has great influence on growth as well as ethrel improves the yield attributing parameters in cucurbits.

Keywords: Plant growth regulators, cucurbits, ethrel

Introduction
Cucurbits
Cucurbits belong to the family cucurbitaceae and form an important, a large group of vegetables, grown extensively throughout India and other tropical and subtropical regions of the globe. In temperate regions some of the cucurbits like cucumber and chow- chow (chayote) are grown in greenhouses as well as under open conditions. The fruits of cucurbits are consumed fresh as a dessert (muskmelon and watermelon) or in salads (cucumber and long melon), cooked (bottle gourd, bitter gourd, sponge gourd, ridge gourd, summer squash, squash melon, pumpkin etc.) and processed in pickles (gherkins, pointed gourd), jam (pumpkin) or candied (ash gourd). Cucurbits with a tough rind (bottle gourd and summer squash) are used for containers, cutlery, musical instruments, ornaments etc. Dry fruits of sponge gourd are used as scrubbing pads. The colorful ornamental gourds that come in a variety of shapes and sizes are used as decoration pieces. Most of the cucurbits are annuals, direct sown and propagated through seed.

Plant growth regulators defined as naturally occurring or synthetic compounds mostly exist in these plants. As a result of major plant growth regulators started with Charles Darwin and his child, Francis Darwin experiment. They observed the growth of coleoptiles of canary grass towards the light source phototropinism followed by a series of experiments and they concluded the presence of a transmittable substance that influences the growth of canary grass towards the light. Later on that substance we know as auxin and isolated by F. W. Went. Gibberellins or gibberellic acid have been reported in muskmelon (Brantley and Warren 1960) and watermelon (Rehm, 1952; Gopalakrishnan and Choudhary. 1978) and in bottle gourd (Choudhary and Phatak, 1959; Atsman et al., 1968) in muskmelon (Brantley and Warren 1960) in bottle gourd (Choudhary and Phatak, 1959; Atsman et al., 1968) in muskmelon (Brantley and Warren 1960) [11, 4], in muskmelon (Brantley and Warren 1960) [17], in bottle gourd (Choudhary and Babel, 1969) [10] and in watermelon (Rehm, 1952; Gopalakrishnan and Choudhary, 1978) [32]. Certain growth regulating chemicals viz., NAA, GA3 and 2,4-D have been reported to influence...
sex expression in various cucurbits, leading to either suppression of male flowers or an enhancement in the number of female flowers. The growth regulators suppress the number of male flowers on lateral branches. Therefore, they increase the female flower production on lateral branches and thereby finally increase the yield.

**Auxin**

Charles Darwin was the first who proposed the existence of auxin in 1880. It was the first class growth regulator that was discovered. Auxins are those compounds that give positive effect on formation of bud, enlargement of cell and root initiation and they are also helpful for the formation of other growth hormones. IAA is natural occurring hormone while NAA, IBA, 2-4D etc. are synthetic in nature. Apical dominance, root induction, control fruits drops, regulation of flowering, parthenocarpy, phototropism, geotropism, herbicides, inhibit abscission, sex determination, xylem differentiation, nucleic acid activity.

**Gibberelic acid**

Kurosava was the Japanese scientist who discovered gibberellins in 1926. It is the second growth regulator. It was extracted from the fungus *Gibberella fujikuroi* which is the causal organism of “foolish seedling of rice”. GA stimulates germination of seed and maturation of flower and fruit. Stimulate cell division and elongation, stimulate germination of seeds Stimulates bolting/Flowering in response to long days, prevention of genetic dwarfism, increase flower and fruit size, dormancy, induces maleness in dioecious flowers, extending shelf life.

**Cytokinins**

Skog in 1995 experimented that when pith tissues of *Nicotiana tabacum* were separated from the vascular tissues they grew without division of cell. There are so many different synthetic cytokinins such as 6-benzylamino purine (BAP), kinetin, 6-(benzyl-amino)-9-(2-tetrahydropranyl)-9H-purine (PBA), 1,3-diphenylurea, thidiazuron (TDZ), etc. Cytokins promotes cell division, cell enlargement and cell differentiation, stimulate bud initiation and root growth, translocation of nutrients, prolong storage life of flowers and vegetables, prevent chlorophyll degradation, morphogenesis, lateral bud development, delay of senescence.

**Ethylene**

This hormone is a gaseous plant hormone which is synthesized from methionine and it is synthesized in all organs of plant. Induce uniform ripening in vegetables, promotes abscission, senescence of leaf.

**Abscisic acid**

It is also called plant stress hormone. It acts as inhibitory chemical compound that gives direct effect on growth of bud, seed and dormancy of bud. It has inhibitory effect and occurs naturally in plants. It inhibits mRNA and synthesis of protein. Act as plant stress hormone, dormancy induction of buds and seeds, induces seeds to synthesize storage proteins, dormancy, seed development and germination, stomata closing.

**Effect of PGR On Growth of Cucurbits**

**Cucumber**

Plant growth regulators are beneficial to increase the growth parameters. The application of maleic hydrazide @ 100 ppm + Ethephon @ 100 ppm increased number of nodes per main stem, and number of nodes per unit length of vine in cucumber cv. Cucumber Long Green. (Thappa et al., 2011) [35]. The concentration of auxin plays vital role to influence growth parameters. GA3 20 ppm + NAA 100 ppm increased vine length, number of primary branches, number of leaves in cucumber cv. Pusa Uday (Dalai et al., 2016). As similar when GA3 applied at 100 ppm it gives beneficial result in vine length, number of leaves, number of branches and leaf area (Kadi et al., 2019).

**Bitter gourd**

Auxin stimulates the growth in the plants to increase the number of male and female flowers and affects the sex ratio in cucurbits. The sex ratio of cucurbits is very high. When GA3 applied at 75 ppm in bitter gourd it resulted in decrease the male female ratio in cv. Faisalabad Long. (Ghani et al., 2013) [18]. Application of NAA at 50 ppm in bitter gourd resulted in the higher leaf area and leaf area index (Arvindkumar et al., 2014) [3] and with same concentration it also increased minimum days to first female flower appearance and male: female sex ratio by increasing the female flowers by suppressing the male ones. (Mia et al., 2014) [29] while higher concentration of NAA 150 ppm also decrease the sex ratio in cv. BARI Karol. (Khatoon et al., 2019) [2]. Ethrel is used to increase female flowers in some cucurbits. the application of ethrel @ 200 ppm resulted in earliness to first pistillate flower appearance, delayed male flower appearance, highest female flowers, minimum number of male flowers and narrow sex ratio in bitter gourd cv. VK 1 Priya (Aishwarya et al., 2019) [1].

**Bottle Gourd**

The exogenous application of GA3 might have stimulated cell division and cell elongation. Consequently increase rate of growth and development of plant. GA3 30 μmol /L increased number of pistillate flowers and lowest sex ratio in cv. Faisalabad Round. (Hidaytullah et al., 2012) [20]. When it is applied in higher concentration 100 ppm is resulted in increased in length of main vine, number of nodes per plant in cv. G 2 (Ansari and Chowdhary, 2018) [2] and the same result was observed when it applied at 150 ppm (Kumari et al., 2019). Maximum number of female flowers and lowest sex ratio were found with treatment of ethrel @ 600 ppm in cv. ABG 1 (Patel et al., 2017) [30].

**Watermelon**

GA3 35 ppm increased main axis and number of male flowers in cv. Sugar Baby. (Babu, 1999) [5]. Similar result obtained by application of GA3 30 ppm in cv. Durgapura Lal (Chaudhary et al., 2014). The half dose of GA3 15 ppm also increased number of branches and length of main axis in cv. Shine beauty. With the higher concentration of GA3 150 ppm resulted increased the number of primary branches, length of main axis and minimum days to appearance first male flower in cv. Sugar Baby (Dadwadiya, 2002). Maximum plant weight and number of branches increased with ethrel 500 ppm.

**Musk melon**

Application of ethrel 150 ppm beneficial for increased number of female flower and improve sex ratio in cv. Khushboo (Chaurasiya et al., 2015). Combination of NAA 100 ppm + ethrel 150 ppm increased number of male and female flowers in Pusa Sharbati. (Devi et al., 2015) [14].
Application of GA3 20 ppm increased number of length of main axis and number of branches (Hadvani, 2010). \(^{19}\)

**Effect of PGR on Yield of Cucurbits**

**Cucumber**

Plant growth regulators affect the physiology of the crops and improve the yield parameters of the plant. Application of maleic hydrazide @ 100 ppm + ethephon @ 100 ppm resulted in maximum number of fruit, maximum fruit weight (kg) and yield per hectare (t) in cv. Cucumber Long Green (Thappa et al., 2011) \(^{33}\). In another trial the combination of GA3 20 ppm + NAA 100 ppm beneficial in maximum number of fruits per plant, weight of fruit (g), fruit yield per plant and total yield per hectare (q) cv. Pusa Udaya. (Dalai et al., 2016). The similar result obtained with application of etheal 600 ppm in cv. Gujarat Cucumber 1 (Nayak et al., 2017) \(^{27}\) and with GA3 100 ppm (Kadi et al., 2019) \(^{21}\)

**Bitter gourd**

In bitter gourd auxin play major role in improve the yield attributes. Dostogir et al. (2006) \(^{15}\) reported that application of GA3 40 ppm increase fruit weight (g) and yield per plant (kg) in cv. Tia. In other experiment GA3 at 50 ppm beneficial for number of fruits per plant and yield per plant (kg) in cv. Pusa Hybrid 1 (Nagamani et al., 2008). With the higher concentration of auxin, the application of NAA at 100 ppm also increased number of fruits per vine and total fruit yield per vine (kg) in cv. Faisalabad Long (Ghani et al., 2013) \(^{18}\). Similar result obtained with the application of NAA at 150 ppm in cv. BARI Karola 1. (Khatoon et al., 2019) \(^{2}\)

**Bottle gourd**

Maximum number of fruits per plant and average fruit weight (kg) obtained with the application of GA3 30 μ mol/L in cv. Faisalabad Round. (Hidayatullah et al., 2012) \(^{20}\). Application of etheal at 100 ppm resulted in maximum yield per vine (kg) and yield per hectare (q) in bottle gourd. (Mahala et al., 2014, Ansari and Chowdhary, 2018) \(^{24}, 2\). With the higher concentration etheal at 200 ppm also increased number of fruits, yield per vine (kg) and yield per hectare (q) in cv. Narendra Rashmi (Kumari et al., 2019) \(^{23}\).

**Watermelon**

Number of fruits per plant increased with the application of ethrel 625 ppm in cv. Sugar Baby (Shinde et al. 1994) \(^{33}\) with lower concentration of ethrel 300 ppm also decrease the days of first harvest (Dadwadiya, 2012) \(^{12}\). Application of GA3 at 25 ppm increased number of fruits per plant, fruit weight (g) and yield per hectare (q) in cv. Sugar Baby (Babu, 1999) \(^{5}\). The average fruit weight was obtained with GA3 15 ppm in cv. Shine Beauty (Sinojiya et al., 2015) \(^{34}\).

**Muskmelon**

Maximum TSS and total sugar were found with the application of ethrel 200 ppm in muskmelon cv. Khushboo. (Chaurasiya et al., 2015). Fruit diameter, fructose, glucose and ascorbic acid obtained with the application of GA3 100 μM in cv. Galia. (Ouzounidou et al., 2008) \(^{28}\). Highest total sugars, reducing sugar, ascorbic acid and lowest acidity were observed in MH 300 ppm in cv. Rasmadhuri (Hadvani, 2010) \(^{19}\)

**Conclusion**

Plant growth regulators influenced the morphological and growth parameters. The application of GA3 at low concentration affects the growth of plant and increases the growth parameters like number of male flower and appearance of first male flower. Auxin generally affects the growth and increase the number of branches and leaves. The application of ethrel influenced sex ratio by increase the number of female flower and suppressed male flowers. It is also increase the yield parameters. MH and TIBA generally affects the quality parameters; TSS and ascorbic acid and.

**References**


