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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 GA_3 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 sub tropical 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 atlow dosages that affect developmental or metabolic processes in higher plants (Rademacher, 2016) [31]. The application of plant growth regulators in agriculture has started in 1930 in United States (Fishel, 2006) [16]. The discovery 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 phototropism 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 was formerly found in uninfected rice seedlings and was reported by E. Kurosawa. F. Skoog and Miller discovered another growth-promoting substance named kinetin (cytokinins).

Role of Plant growth regulators on cucurbits

Plant growth regulators have profound influence on fruit production in cucurbits. It can modify sex expression, improve fruit set, and ultimately increase the yield in number of cucurbits. A relationship between growth substances and sex expression probably exists in these plants. Sex modification shifts towards femaleness in sex expression by exogenous application of auxins, gibberellins, growth retardants, other plant growth regulators, macro and micro nutrient elements which have been reported in (Choudhary and Phatak, 1959; Atsman *et al*., 1968) [11, 4], in muskmelon (Brantley and Warren 1960) [7], 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.

Gibberellic 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

Skoog in 1995 experimented that when pith tissues of *Nicotiana tabaccum* 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-tetrahydropyranyl)-9H-purine (PBA), 1,3-diphenylurea, thidiazuron (TDZ), *etc*. Cytokinins 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 andseeds, 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. GA_3 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 GA_3 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 GA_3 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 italso 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) [25] 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 GA_3 might have stimulated cell division and cell elongation. Consequently increase rate of growth and development of plant. GA_3 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

GA_3 35 ppm increased main axis and number of male flowers in cv. Sugar Baby. (Babu, 1999) [5]. Similarresult obtained by application of GA_3 30 ppm in cv. Durgapura Lal (Chaudhary *et al.*, 2014). The half dose of GA_3 15 ppm also increased number of branches and length of main axis in cv. Shine beauty. With the higher concentration of GA_3 150 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.

Muskmelon

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 GA_3 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) [35]. In another trail the combination of GA_3 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 Uday. (Dalai *et al*., 2016). The similar result obtained with application of ethrel 600 ppm in cv. Gujarat Cucumber 1 (Nayak *et al*., 2017) [27] and with GA_3 100 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 GA_3 40 ppm increase fruit weight (g) and yield per plant (kg) in cv. Tia. In other experiment GA_3 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 ofauxin, 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 GA_3 30 µ mol/ L in cv. Faisalabad Round. (Hidaytullah *et al*., 2012) [20]. Application of ethrel 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 ethrel 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 GA_3 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 GA_3 15 ppm in cv. Shine Beauty (Sinojiya *et al*., 2015) [34].

Muskmelon

Number of fruits per vine and yield per hectare (q) were obtained with the application ofethrel 150 ppm in cv. Khushboo (Chaurasiya *et al*., 2015). The combination of NAA150 ppm + ethrel 250 ppm also increased number of fruits per vine. Fruit weight (g) and fruit yield per hectare in cv. Pusa Sharbati. (Devi *et al*., 2015) [14]. Similar result obtained with the foliar spray of MH 300 ppm in cv. Rasmadhuri (Hadvani, 2010) [19].

Effect of PGR on Quality of Cucurbits

Cucumber

Increase in N, P and Ca content was observed with the application of potassium nitrate 2.5 $g.dm^{-3}$ with GA_3 0.01$g.dm^{-3}$ in cv. Seven Star F_1. (Pal *et al*., 2016). Maximum TSS was recorded in the treatment GA_3 200 ppm (Kadi *et al*., 2019) [21].

Bitter gourd

The quality characters like length of fruit and width of fruit obtained with the application of GA_3 @ 40 ppm in cv. Tia. (Dostogir *et al*., 2006) [15]. Similar result obtain with ethrel 50 ppm in cv. Pusa hybrid 1. (Nagamani *et al.*, 2008). The total chlorophyll content was improved with the treatment NAA 50 ppm in cv. Pusa Visesh. (Arvindkumar *et al*., 2014) [3] Similar result obtain with NAA 50 ppm in cv. (Biradar *et al*., 2010) [6].

Bottle gourd

Ethrel plays pivotal role in improve quality characters of bottle gourd. Application of ethrel 300 ppm was found most effective in increasing fruit diameter, crude protein content, ascorbic acid content and TSS in bottle gourd. (Mahala *et al*., 2014) [24]. The length and width of fruit increased with the application of ethrel 100 ppm in cv. G 2. (Ansari and Chowdhary, 2018) [2].

Watermelon

Shinde *et al*. (1994) [33] revealed that application of NAA 50 ppm increased TSS in cv. Sugar Baby. Similar result obtain with treatment GA_3 25 ppm cv. Sugar Baby. (Babu, 1999) [5]. Maximum chlorophyll content was observed with the application of GA_3 30 ppm in cv. Durgapura Lal. (Choudhary *et al*., 2014). [24] Maximum pulp weight was recorded in GA_3 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 GA_3 100 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 GA_3 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.

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