A CRITICAL REVIEW: EFFECT OF PLANT GROWTH REGULATORS ON GROWTH AND YIELD OF CUCURBITS

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ABSTRACT: Crops belonging to family Cucurbitaceae are generally known as “cucurbits”. As a group, cucurbits occupy the largest area in India and in other tropical countries. Cucurbits are rich source of calories, minerals and vitamins. The seeds of cucurbits are valued for high oil and protein contents. Seed proteins of cucurbits are comparable to that of legumes and are richer in methionine. Cucurbits respond well to the application of plant growth regulators. To enhance productivity and food safety, Indian Agriculture become more mechanized and science based by using inputs and the plant growth regulators are among of them; plant growth regulators have quicker impact on vegetative as well as yield of the crops. As it have various advantages like less time consuming to treat the plant and environment friendly. In cucurbits application of PGRs stimulates the growth by helping in elongation of the vines, boosts fruit setting, influences the morphological and growth parameters and helps the plants withstand disease related problems. 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 ethereal influenced sex ratio by increase the number of female flower and suppressed male flowers which ultimately increases the yield parameters. Exogenous application of PGRs effect on endogenous hormone of plant which alter the physiological processes of the plant. Various types of plant growth regulators in recommended concentrations give better growth, early flowering and minimum sex ratio, highest fruit yield with superior quality of fruit. Mostly, the growth regulator helps in the production of marketable fruit in minimum number of days. Different PGRs applications showed significant effect on stem length, number of branches, total number of flower, fruiting, yield and other yield contributing characters. It is obvious that changes in the level of endogenous hormones due to biotic and abiotic stress alter the crop growth and any sort of manipulation including exogenous application of growth substances would help for yield improvement or at least sustenance of the crop. Hormones usually move within plant from a site of production to site of action. Phytohormones are physiological intercellular messengers that are needed to control the complete plant lifecycle from germination to death of the plant. In addition, plant hormones are secreted in response to environmental factors such as abundance of nutrients, drought conditions, light, and temperature, chemical or physical stress. Hence, levels of hormones will change over the lifespan of a plant and are dependent upon season and environment. Use of growth regulators in cucurbits production must be specific in their action and should be toxicologically and environmentally safe. From this review it has been concluded that PGRs regulate physiological process to the cucurbits crop plants like rooting, flowering, growth, sprouting, ripening and use of PGRS in cucurbits production found to be beneficial for yield and yield contributing characters.

KEYWORDS: Plant growth regulators, cucurbits, ethephon, Auxin, GA₃

INTRODUCTION: Cucurbits are the major group of vegetables grown all over World and they are responsive crops towards the growth regulators. PGR’s play vital or key role in increase growth, yield and quality of the cultivated cucurbitaceous crops. Plant growth regulators are chemical substances and when applied in small amounts, they bring rapid changes in the phenotypes of the plant and also influence the plant growth, right from seed germination to senescence either by enhancing or by stimulating the natural growth regulatory system. The main goal of research on cucurbits in India is to double the productivity on sustainable basis. Plant growth substance are known to enhance the source – sink relationship and stimulate the translocation of photo assimilates there by helping in effective flower formation, fruit and seed development and ultimately enhance the productivity of crops. Most of the physiological activates and growth in plants are regulated by action and interaction of some chemical substances in them is called hormones and by some naturally occurring inhibitors. Plant growth regulators greatly improves plant vigour, promotes growth of roots and shoots and also known to reduce stress. Indigenous cucurbitaceous vegetables like cucumber, bitter gourd, pointed gourd, ash gourd, teasel gourd etc. have significant nutritional, medicinal and economic importance due to presence of several bioactive compounds responsible for therapeutic activities, usefulness for processing purpose and comparatively higher market price. Cucurbits are variously used as food, medicine, as well as utilitarian and ornamental items. Some cucurbits possess industrial importance too. About 60 cucurbit crops are grown in India and half of these are indigenous to India or Indian subcontinent. These cucurbits are consumed in various forms i.e., salad, sweet, pickles and others in culinary purpose. Cucurbits share about 5% of the total vegetable production in India which includes indigenous cucurbits. Being the largest group of vegetables, cucurbits provide better scope to enhance overall productivity and production of vegetable to meet the challenges. Most of the cucurbits are annuals, direct sown and propagated through seed. Cucurbits respond well to the application of PGRs. Plant growth regulators defined as naturally occurring or synthetic compounds mostly exist at low dosages that affect developmental or metabolic processes in higher plants (Rademacher, 2016). Plant growth regulators have profound influence on fruit production in cucurbits. It can modify sex expression, improve fruit set, and ultimately increase the yield 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) in muskmelon (Brantley and Warren ,1960) in bottle gourd (Choudhary and Babel, 1969) and in watermelon (Rehm, 1952; Gopalakrishnan and Choudhary, 1978). 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 increasing the yield. plant growth regulators provide an immediate impact on crop improvement programmes and are less time consuming, applications of plant growth regulators must lead to quantifiable advantages for the user. Plant hormones are not nutrients, but chemicals that in small amounts promote and influence the growth, development, and differentiation of cells and tissues. Vascular tissues are used to move hormones from one part of the plant to another; these include sieve tubes or phloem that move sugars from the leaves to the roots and flowers, and xylem that moves water and mineral solutes from the roots to the foliage. Growth regulators can improve the physiological efficiency including photosynthetic ability. Foliar application of growth regulators and chemicals at the flowering stage may improve the physiological efficiency and may play a significant role in raising the productivity of the crop (Dashora and Jain, 1994). Hence plant growth regulators greatly influence the growth and finally the yield in various cultivated cucurbits.

REVIEWS:
BITTERGOURD
Banerjee & Basu (1994) studied the effect of gibberellic acid and ethrel on fruit setting and development of *Momordica charantia* L. Both GA₃ and ethrel in lower concentrations promoted female flower production as well as fruit setting and development. Both growth regulators improved the quality of the *Momordica* fruit by increasing length, breadth and biomass of the fruits as well as by increasing the content of total sugar of the fruit. In bitter gourd auxin play major role in improve the yield attributes. Dostogir *et al.*, (2006) reported that application of GA₃ @40 ppm increase fruit weight (g) and yield per plant (kg) in cv.Tia. GA₃ at 50 ppm beneficial for number of fruits per plant and yield per plant (kg) in cv.Pusa Hybrid 1(Nagamani *et al.*, 2015). Geeta Biradar *et al.*, (2012) studied the effect of plant growth regulators on yield, biochemical and physiological characters of bitter gourd (*Momordica charantia* L.) and the study revealed that growth regulators had significant effect on conversion of sex ratio of flowers, which helps in enhancing the yields of the crop. Application of plant growth regulators significantly increased the biochemical and physiological characters in bitter gourd and foliar application of GA₃ @ 20 ppm was most effective in increasing the fruit yield and yield components such as No. of female flowers, no of fruits per plant. Auxin stimulates the growth in the plants to increase the number of male and female flowers and affects the sex ratio in cucurbits. When GA₃ applied at 75 ppm in bitter gourd it resulted in decreasing the male female ratio and with the higher concentration of auxin (NAA at 100 ppm) increased number of fruits per vine and total fruit yield per vine (kg) in cv. Faisalabad Long (Ghani *et al.*, 2013). M.A. Baset Mia *et al.*, (2014) reveals that the flower synchrony, growth and yield enhancement of small type bitter gourd (*Momordica charantia* L.) through plant growth regulators and NPK fertilization and indicated that application of different doses of NPK fertilizer and plant growth regulators (GA₃, NAA and Ethephon) significantly influenced over the flower initiation and fruit setting. The application of N90-P45-K60 fertilizer along with Ethephon spraying resulted in the better yield of small sized bitter gourd. Application of NAA at 50 ppm in bitter gourd resulted in the higher leaf area and leaf area index (Arvind kumar *et al.*, 2014). Anjita J. Hirpara *et al.*, (2015) studied the effect of exogenous application of various levels of Gibberellic Acid ([[GA.sub.3]]; 25 and 50 ppm), ethrel (250 and 500 ppm), Naphthalic Acetic Acid (NAA; 50 and 100 ppm) and Cycoel (CCC; 100 and 200 ppm) on flowering fruiting and fruit yield in bitter gourd (*Momordica charantia* L.) plants cv. Phule Green Gold. Among all the foliar agents, the response of [GA.sub.3] and ethrel was found better. However, foliar spray with different combinations of CCC did not improve yield and yield contributing attributes. Khatoon *et al.*, (2019) studied the effect of foliar spray of GA₃ and NAA on sex expression, yield and yield component of bitter gourd (*Momordica charantia* L.) var. BARI Karola-1. Spraying of NAA @ 150 ppm gave the maximum fruit yield, gross return and net return with the highest BCR of 3.17 while higher concentration of NAA@ 150 ppm also decreases the sex ratio. 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). GA3 application had positive effect on the number of staminate flowers, number of fruits per hill, and fruit yield. GA3 at 10 ppm resulted a greater number of staminate flowers. More number of fruits/hill and fruit yield per hectare were attained using 50 ppm than no application. Application of the PGR significantly increased the fruit yield.GA3 application was profitable than no application reported by Raymond *et al.*, 2018.

BITTELEGOURD
Singh *et al.*, (1969) studied Vegetative growth, flowering and fruiting of bottle-gourd (*Lagenaria siceraria* (Mol) Standl.) and reported that high levels of GA @75 ppm and asafoetida @0.25% and low levels of MH@100 ppm and NAA@25 ppm greatly enhanced shoot length, with no significant differences in the production of laterals. Mandal,(1990) to study the response of bottle gourd (*Lagenaria siceraria* L.) to some plant growth regulators on bottle gourd cv, Pusa Summer Prolific Long and observed that Ethrel at 10 or 20 ppm was the most effective treatment for increasing yields. Arora *et al.*, (1988) studied the effect of plant growth substances on growth, flowering, sex-expression and fruit yield in bottle gourd (*Lagenaria siceraria* (Mol) Standl.) and observed the highest average yields were obtained with Planofix at 50 mg/litre (316.8 q/ha) and with Atonik (nitrophonolate-sodium + nitroguaiacol-sodium) at 0.1% (316.2 q/ha). Baruah *et al.*, 1997 studied the effect of plant growth regulators on growth, flowering and yield of bottle gourd at different sowing dates, *Lagenaria siceraria* (cv. Kiyari Lao) and reported that Plants sprayed with NAA at 25 ppm or MH at 50 ppm produced the best yields. Rai *et al.*, (2003) studied the effect of different
concentration of paclobutrazol (pp333) on growth, flowering and quality of bottle gourd. All the concentration paclobutrazol significantly decreased vine length, leaf size and fruit length, whereas, side branches, fruit/plant, fruit diameter, TSS and dry matter content were increased. Besides these, paclobutrazol also caused early appearance of female flowers on the nearest node (from bottom). From yield and quality point of view, paclobutrazol at 175 mg P was found superior. Kore et al., (2003) studied the Effect of growth regulators on growth, flowering and yield of bottle gourd Lagenaria siceraria variety Samrat under Konkan conditions and reported that triacontanol, NAA, gibberellic acid and paclobutrazol showed significant effect on growth, flowering and yield of bottle gourd. Kakroo et al., (2005) studied the effect of growth regulators on flowering, fruiting and yield characters of bottle gourd Lagenaria siceraria (Mol.) Standl. cv SH-BG-1 under Kashmir conditions and found that Ethrel at 150 ppm produced the highest number of female flowers and the lowest number of male flowers per plant, and showed the minimum sex ratio. Sanjay Kumar et al., (2006) studied the effect of plant growth regulators on yield and yield attributing characters of bottle gourd (Lagenaria siceraria) (Molina) Standl cv. Pusa Naveen and reported that Ethephon at 300 ppm produced the highest number of fruits and fruit yield per plant. The exogenous application of GA₃ might have stimulated cell division and cell elongation. Consequently, increase in rate of growth and development of plant. GA₃ 30 μmol /L increased number of pistillate flowers, lowest sex ratio, maximum number of fruits per plant and average fruit weight (kg) in cv. Faisalabad Round. (Hidayatullah et al.,2012). Kumari (2013) studied the effect of plant growth regulators and thiourea on growth, yield and quality of bottle gourd [Lagenaria siceraria (Mol.) standl.] Cv. Pusa Summer Prolific Long and the results showed that most effective treatment for increasing the fruit growth and yield of bottle gourd was ethrel 450 ppm. 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). 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). Ansari and Chowdhary (2018) studied the effect of boron and three plant growth regulators (PGRs) viz. gibberellic acid (GA), maleic hydrazide (MH) and ethrel (E) for vegetative, physiological and fruit characters of bottle gourd. And suggested that the significant increase in growth, sex-expression and fruit characters would be obtained by the spraying of Ethrel @100 ppm at 2 and 4 true leaf stages along with the seed soaking by boron (0.05%) for 12 hours. Komal kumari et al., (2019) observed the effect of plant growth regulators on growth and yield of bottle gourd (Lagenaria siceraria (Mol.) Standl.) and suggested that the significant increase in growth and fruit characters would be obtained by the spraying of ethrel 200 ppm at 2 and 4 true leaves. Wamiq et al., (2020) studied the effect of GA₃ and NAA on yield of bottle gourd (Lagenaria siceraria) cv (MGH-4) and reported that application of 40 ppm gibberellin at 2, 4 leaf stage was found most effective in terms of number of female flowers per vine, fruit per plant, fruit yield per plant, fruit yield per hectare.Manish Kumar et al., (2020) concluded that foliar application of Ethrel @ 300 ppm sprayed at different stages of growth i.e., at two true leaf stage, four true leaf stage and flower initiation stage was beneficial for higher seed yield and better growth of plant in case of bottle gourd.Soni et al., reported that application of 200 ppm Ethrel significantly reduced number of days to first flower and first harvesting, enhance the female flower, narrower the sex ratio, increase the fruit weight, length and diameter and also increased the fruit yield followed by 200 ppm NAA and 5 ppm GA₃,Moniruzzaman et al.,2020 reported that Growth regulator treatments had significant effect on primary branches/plant, node number of 1st male and female flower appearance, number of days to 1st male and female flower appearance, number of male and female flowers, sex ratio (male:female flower) number of fruits/plant, individual fruit weight and fruit yield. Spraying of MH @ 150 ppm gave the highest primary branches/plant, induced maximum female flowers at lower nodes, early appearance of female flowers on the nearest node (from bottom), gave the lower number of male flowers, highest number of female flowers/plant, produces lower male:female sex ratio, maximum number of fruits/plant, maximum fruit weight/plant ,highest fruit yield per hectare , highest mean yield, gave the maximum gross return and net return with the highest BCR of 5.24.

IVY GOURD
Prabhu et al., (2006) studied the effect of growth regulators on fruit characters and seediness in ivy gourd (Coccinia grandis L.). The results showed that, GA₃ 100 ppm and 2, 4, D 100 ppm were found to be more effective on fruit girth and fruit weight. Among the treatments, GA₃ 100 ppm and NAA 400 ppm produced lesser number of seeds and gave better individual fruit weight.

MUSKMELON
E. El-Kholy et al., (1982) studied effect of some growth regulators on yield and quality of sweet melon and muskmelon. The highest early and total yields of both sweet melon and muskmelon resulted from spraying ethrel on the foliage. Generally, two sprays of ethrel solution produced the most consistent effects on yield and yield quality with both sweet melon and muskmelon.Application of GA₃ 20 ppm increased number of lengths of main axis and number of branches (Hadvani, 2010). Foliar spray of MH 300 ppm in cv. Rasmadhuri increased number of fruits per vine,fruit weight and fruit yield per hectare (Hadvani, 2010).Devi et al., 2015 noted that combination of NAA 150 ppm + Ethrel 250 ppm increased number of male and female flowers in Pusa Sharbati. The number of fruits per vine, fruit weight. The yield characters such as fruit diameter and yield per plant were observed maximum in the treatment NAA 150 ppm + Ethrel 250 ppm. The application of NAA 150 ppm + ethrel 250 ppm observed to be the best treatment. Number of fruits per vine and yield per hectare (q) were obtained with the application of ethrel 150 ppm. Application of ethrel 150 ppm beneficial for increased number of female flower and improve sex ratio in cv. Khushboo. Jagdeep Chaurasiya et al., (2016) studied influence of plant growth regulators on growth, sex expression, yield and quality of Muskmelon (Cucumis melo L.) and the results revealed that GA₃ and NAA promoted melon growth, while a significant inhibition with Ethrel was observed. The maximum stem length, Number of leaves per plant, number of nodes in main stem and average fruit weight were registered by the treatment GA₃ 60 ppm. Whereas ethrel 150 ppm proved one of the best treatment in respect of number of primary branches per plant, reduces days to first pistillate flower, increased number of pistillate flower per plant, lowest sex ratio, highest no of fruits per plant and yield per ha.Ethrel 200 ppm significantly delayed the anthesis of first staminate flower from anthesis of first pistillate flower and earliest fruit maturity or lowest number of days taken to first fruit
CUCUMBER
Kim et al., (1988) studied effect of plant growth regulators, GA3 and PCPA on the growth and quality of cucumber (Cucumis sativus L.), and reported that GA3 application at flower and late young fruit stage by spraying was the more effective in preventing the formation of the curved shape fruits. From the commercial view point, treatment of GA3 at PCPA at 5ppm by flower spray method at blooming time were recommended for the best use of two plant growth regulators. Thappa et al., (2011) studied the influence of plant growth regulators on morphological, floral and yield traits of cucumber (Cucumis sativus L.) and the results revealed that 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, maximum number of fruits, maximum fruit weight (kg) and yield per hectare (t) in cucumber cv. Cucumber Long Green. Plant growth regulators affect the physiology of the crops and improve the yield parameters of the cucumber plant. This treatment also produced the best economic results for the production of cucumber.

Trivedi BN (2011) studied the effect of plant growth regulators on growth, flowering, sex-expression, quality and yield of cucumber (Cucumis sativus L.) Cv. Guj-Cucumber-1” and finally concluded that application of ethrel 300 ppm enhanced number of fruits per vine and resultanty produced highest fruit yield. Similarly, with economic point of view, Ethrel 300 ppm also gave the highest net return and CBR. Dalai et al., (2020) studied the effect of foliar application of GA3 and NAA on growth, flowering yield and yield attributes of cucumber [cucumis sativus L] and suggested that, a dose of GA3 @ 20 ppm + NAA@100 ppm was found significantly superior in terms of growth parameters i.e., Vine length plant-1 (cm), Number of primary branches plant-1, Number of leaves plant-1 and produced highest yield of cucumber. S. Hikosaka and N. Sugiyama (2015) studied the effects of exogenous plant growth regulators on yield, fruit growth, and concentration of endogenous hormones in gynoecious parthenocarpic cucumber (Cucumis sativus L.) It has been reported that parthenocarpic cucumbers with many female flowers and heavy fruit load often show fruit abortion and reduced fruit yield. To achieve the stable fruit production, it is necessary to elucidate the mechanism involved in fruit abortion in cucumbers via fruit load and endogenous plant hormones. The effects of exogenous plant growth regulators (PGRs) on yield and fruit growth were examined in a gynoecious, parthenocarpic cucumber (Cucumis sativus L.) and the results suggest that exogenous PGRs affect the overall concentration of PGRs, as well as that of other endogenous plant hormones. However, PGRs may not be associated with fruit abortion when the fruit load is low. In conclusion, fruit load may have a greater influence on fruit abortion than that of PGRs. Pal et al., (2016) studied Cucumis sativus L. is an important fruit vegetable with great economic potential. A study was carried out to evaluate the potential of exogenously applied potassium nitrate and gibberellic acid in combination on growth, development and yield of the F1 hybrid cucumber cv. ‘KUK-9’ under protected cultivation. Overall results suggest that foliar application of GA@0.01g/l and Potassium nitrate@2.5 g/l had maximum effect on growth, development and yield of plants. Foliar application of potassium and gibberellic acid may be effective to maximize cucumber growth, physiological status and yield parameters. In another trial the combination of GA3 20 ppm + NAA 100 ppm beneficial in increasing vine length, number of primary branches, number of leave maximum number of fruits per plant, weight of fruit (g), fruit yield per plant and total yield per hectare (q) in cucumber cv. Pusa Uday (Dalai et al., 2015). Barbhola et al., (2017) studied the effect of plant growth regulators on cucumber (cucumis sativus L.) under protected cultivation and the results revealed that influence of the plant growth regulators was variable on the morphological traits of cucumber but the floral and yield traits were significantly affected by a combined application of maleic hydrazide @ 200 ppm and ethephon 200 ppm. This treatment induced early development, maximized yield and also produced best economic results for the production of cucumber. Nayak et al., (2018). Studied the influence of pinching and plant growth regulators on morphological and physiological characters of cucumber (Cucumis sativus L.) Cv. Gujarat cucumber-1 and reported that the pinching treatments and the PGRs application significantly influenced the morphological characters such as the length of vine, number of primary branches, number of nodes, internodal distance. All the pinching treatments had significantly influenced the total leaf area and leaf area index of cucumber, while the PGRs failed to have any profound effect on these physiological characters, but significantly enhanced the morphological characters. The interaction effect between pinching and PGRs was found non-significant for both the morphological and physiological characters. Abdul Baqi et al., (2018) studied the Effect of GA3 and NAA with pruning levels on growth, sex expression and yield attributes of cucumber (Cucumis sativus L. Malini F1) under protected condition. The results of the study revealed that, combined application of GA3 and NAA (50 ppm + 500 ppm) with double stem pruning had more significant effects on vegetative growth, increased the flowering, suppressed the stomate and enhanced the pizzatilla flowers, so that the fruit yield was higher per plant and per hectare. Nayak et al., (2018) studied efficacy of pinching and plant growth regulators in enhancing yield characters of cucumber (Cucumis sativus L.) cv. Gujarat Cucumber-1 and reported that the pinching treatments and the PGRs application individually significantly influenced the yield parameters such as the average length of fruit, number of fruits per vine, yield per vine and yield per hectare, but both failed to manifest any evident effect on the average fruit weight. Pinching at 6th node and higher doses of both ethrel @600 ppm and CCC @400 ppm had significantly enhanced most of the yield characters. Kadi et al.,(2019) studied the effect of different plant growth regulators on growth, yield and quality parameters in cucumber (Cucumis sativus L.) under Polyhouse Condition .The treatment with GA3,
100 ppm has recorded the maximum in growth parameters like vine length, number of leaves, number of branches, leaf area like length of fruits, diameter of fruits, number of fruits per plant and fruit yield (q/ha), whereas internodal distance has recorded the maximum in the treatment of NAA (50 ppm). The phenological parameters such as average days taken to first flowering, days taken to 50% flowering and days taken to first picking, maximum fruit set percentage, maximum fruit retention percentage, maximum TSS was recorded in the treatment of GA$_3$ 200 ppm and sex ratio was maximum in the treatment NAA 100 ppm. Pandey et al., (2019) studied the influence of ethephon on vegetative character, flowering behaviour and sex expression of cucumber cv. Bhaktapur Local. It was observed that ethephon @ 400 ppm produced significantly higher number of nodes per plant, maximum number of primary branches, caused earlier female flowering, increased total female flowers per plant also sex ratio. Ethephon @ 600 ppm produced more nodes, produced female flowers at the lowest node and male flowers at the uppermost node, delayed the appearance of first male flower by 3 days. Dinesh et al., (2019) studied the efficacy of plant growth regulators (GA$_3$, ethe real and salicylic acid) on growth and flowering of cucumber (Cucumis sativus L.) cv. Malini under shade net conditions and reported that, GA$_3$ at 75 ppm recorded with maximum vine length, number of number of leaves, number of nodes on main stem, length of primary branches and leaf area, whereas, maximum number of primary branches was recorded in ethrel 300 ppm. Further, minimum internodal distance was recorded with GA$_3$ at 250 ppm. With respect to phenological parameters, etrel at 300 ppm exhibited the best results for the minimum number of days taken for first female flower appearance, least node number of first female flower appearance and lowest male to female sex ratio. Finally, yield was recorded highest in GA$_3$ 75 ppm. Al-Sanoussi (2019) studied the effect of seed pre-soaking in gibberellic acid on cucumber (Cucumis sativus L.) plant growth, flowering, and yield to evaluate the potential of seed pre-soaking in different concentrations of gibberellins on cucumber growth, flowering, and yield and reported that, application of GA$_3$ concentration inducing flowering decreased staminate flower number and increased pistillate flower number. The results clearly showed that the foliar application of 10µg/ml GA proved to be the best choice for growing cucumber in terms of growth and yield attributes. Albely Afifa Mir et al., (2019) studied Plant growth regulators: One of the techniques of enhancing growth and yield of Bangladeshi local cucumber variety (Cucumis sativus) ‘Baromashi’ and noted that ethephon 200 ppm showed the best result. S. Gosai et al., (2020) studied the effects of plant growth regulators on growth, flowering, fruiting and fruit yield of cucumber (Cucumis sativus L.) and revealed that the combined use of auxins and gibberellins result in increased secondary growth. Maleic hydrazide (MH) along with Ethephon at 100 ppm each increases the number of nodes and primary branches. Ethrel at 300-400 ppm retards the secondary development and increase femalelessness, and at 200-300 ppm make fruit surface smooth. Silver nitrate (AgNO$_3$) at 400 ppm enhances the maleness in cucumber. Application of Ethephon at 300 ppm reduces the harvesting time of the fruit. Salicylic acid (at 2 doses of 0.07 mmol/l + 0.18 mmol/l) increases chlorophyll content and its exogenous application increases the fruit yield. Maleic Hydrazide (MH) alone at 100 ppm increases the femaleness, inhibits apical growth at 50-100 ppm, and increases fruit size at 200 ppm. S. Dhakal et al., (2019) Studied the effect of ethephon doses on vegetative characters, sex expression and yield of cucumber (Cucumis sativus cv. Bhaktapur Local). The number of nodes, branches per plant, total number of female flowers, total yield was found to be highest with 300 ppm ethephon. Ethrel was found to shift first male flowers and female flowers towards upper and lower nodes respectively.300 ppm of ethephon was found superior for reducing (male: female) sex ratio. Thus, proper use of ethephon is found to be beneficial to farmers.

**WATERMELON**

Abdelrahman et al., (1969) studied the effect of some growth regulating chemicals on earliness and total yield of cantaloupe and watermelon and found that spraying the plants with 100 ppm MH increased earliness and total yield of both crops. Spraying the plants with 200 ppm NAA or with 50 ppm TIBA tended to concentrate the yield, but delay the harvest. Maximum plant weight and number of branches increased with ethrel 500 ppm. Number of fruits per plant increased with the application of ethrel 625 ppm in cv. Sugar Baby (Shinde et al., 1994). GA$_3$, 35 ppm increased main axis and number of male flowers in cv. Sugar Baby. (Babu, 1999). 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). Dixit et al., (2001) studied the effect of plant growth regulators on growth, earliness and sex ratio in watermelon (Citrullus lanatus Thumb) cv. Sugar Baby. The application of ethrel at 500 ppm concentration brought significant improvement in vegetative characters. GA$_3$ (25 and 50 ppm) produced the female flowers at lower nodes and initiated early flowering which consequently led to early yield and lowers sex ratio along with greater number of fruits per plant followed by both concentrations of ethrel (250 and 500 ppm). GA$_3$, 15 ppm increased number of branches and length of main axis in cv. Shine beauty. GA$_3$, 150 ppm increased the number of primary branches, length of main axis and minimum days to appearance first male flower and ethrel 300 ppm decreased the days of first harvest in watermelon cv. Sugar Baby (Dadwadiya, 2012). Application of GA$_3$, 30 ppm increased the main axis and number of male flowers in cv. Durgapura Lal (Chaudhary et al., 2014). Sinojiya et al., 2015 studied the effect of plant growth regulators on growth, flowering, yield and quality of watermelon (Citrullus lanatus Thumb.) CV Shine Beauty and the results revealed that growth characters such as length of main axis, number of branches and number of nodes, average weight of fruit were highest with GA$_3$, 15 ppm. As regard to flowering, lowest days to first male, female and hermaphrodite flower appearance, maximum female: male sex ratio, highest number of fruits per plant and fruit yield were noted highest in MH 200 ppm. Chaudhary et al., (2016) studied the effect of growth substances on growth, flowering, yield and quality attributes of watermelon (Citrullus lanatus Thumb Mans.) cv. Durgapura Lal (RW-177-3) and reported that the maximum length of main creepers at 60 and 90 DAS, number of sub-creepers at 60 and 90 DAS, number of leaves/plant at 60 and 90 days after sowing, maximum chlorophyll content at 45 and 60 days, maximum number of male flowers were recorded with treatment GA$_3$, 30 ppm.TIBA 20 ppm proved to be most effective for producing the lower node number at which first female flower appears, maximum number of female flowers lowered the sex ratio and effective for producing maximum number of fruits, fruit yield/plant, fruit yield/ha and fruit length. The maximum average fruit weight and fruit diameter recorded in TIBA 15 ppm. Meshram et al., (2022) studied the effect of plant growth regulators on yield and quality of watermelon. The results of
experiment revealed that yield contributing characters, chlorophyll index, highest sex ratio (Female: Male, minimum days to first female flower appearance, minimum node at which first female flower appeared, maximum number of fruits, average weight of fruit, fruit yield kg per plant, fruit yield kg per plot, yield per hectare were maximum @TIBA 20 ppm.

RIDGE GOURD
Arora et al., (1987) studied the Effect of plant growth regulators on vegetative growth, flowering and yield of ridge gourd (Luffa acutangula Roxb.) and reported that GA at 25 mg/litre stimulated elongation of the main shoot while Ethrel at 100 mg/litre induced branching. Stamine flowers at the lower nodes appeared early in plants treated with GA at 25 mg/litre, MH at 150 mg/litre or TIBA at 100 mg/litre. Ethrel at 100 mg/litre markedly advanced the appearance of pistillate flowers at the lower nodes, but only during the rainy season. Arora et al., (1988) effect of plant growth regulators on vegetative growth, flowering and yield of sponge gourd, Luffa cylindrica (Linn.) Roem cv Pusa Chikni, and indicated that the total yield was highest in plants treated with Ethrel at 100 ppm. Sha and Gnanasekaran Seerangan (2019) studied the effect of plant growth regulators and micronutrients on growth and yield of ridge gourd (Luffa acutangula L) cv.PKM-1 and concluded that the plant growth regulators and micronutrients viz., 24 epi brassinosteroid 2 ppm + ethrel 250 ppm + micronutrient 2% were identified as the best to increase yield for ridge gourd. Vyas et al., (2015) studied the effect of plant growth regulators on growth, flowering and yield of ridge gourd (Luffa acutangula Roxb L.) cv. Pusa Nasdar. Among all the treatment combination Ethrel 200 ppm was found to be the most effective in increasing a greater number of female flowers, decrease the number of male flowers and thereby reducing the male female ratio, increase the fruit setting, total number of fruits per plant, length of marketable fruits, weight of marketable fruits, thereby fruit yield per plot and per hectare. Hilli et al., (2010) studied the effect of growth regulators and stages of spray on growth, fruit set and seed yield of ridgegourd (Luffa acutangula L. Roxb) and reported that spraying of GA$_2$ @ 50 ppm at four leaf, flower and fruit initiation stage significantly improved the vine length. Maximum number of branches per vine were recorded with spraying of ethrel 500 ppm at four leaf, flower and fruit initiation stage followed by spraying at four leaf and flower initiation stage in both the seasons. Maximum vine length and no. of branches recorded with GA$_2$, 50 ppm at four leaf, flower and fruit initiation stage.

Conclusion:
Nutrients are important and crucial elements, which are required for the plant for its growth and development. The translocation of photosynthates from source to sink is very important for the development of economic part. Plant growth regulators are chemical substances and when applied in small amounts, they bring rapid changes in the phenotypes of the plant and also influence the plant growth and development. The application of different growth regulators has a considerable impact on the growth, flowering, fruiting, and fruit yield of cucurbit plants. Plant growth regulators leave determining impact on the overall growth and developmental processes, such as germination, shoot elongation, leaf expansion, flowering, fruit set, fruit growth and ripening, and the ultimate yield of the plant. Plant growth regulators (PGRs) may have an important role in regulating both yield and fruit quality during the production of cucurbits. Some growth regulators promote the growth of plants while other acts as inhibitors that result in the reduction of growth and yield attributes of plants. Exogenous application of PGRs effect on endogenous hormone of plant which alter the physiological process of plant. Various types of plant growth regulators in recommended concentrations give better growth, early flowering, and minimum sex ratio, highest fruit yield with superior quality of fruit. Different PGRs applications showed significant effect on stem length, number of branches, total number of flower, fruiting, yield and other yield contributing characters. Auxins enhances root elongation, fruit set and fruit development whereas gibberellins enhance the cell elongation and the secondary growth. Cytokinins delay the senescence of the fruit and increase the fruit yield. This way, the review meets the objective of assessing the role of different concentrations of plant growth regulators on growth, flowering, fruiting, and fruit yield of cucurbits and concluded that the application of different growth regulators has a tremendous impact on the growth, flowering, fruiting, and fruit yield of cucurbits plants.

REFERENCES:


