RESEARCH ARTICLE

GROWTH, FLOWERING AND YIELD OF CUCUMBER (*CUCUMIS SATIVUS* L.) AS INFLUENCED BY DIFFERENT LEVELS OF NAA AND GA_3

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Received-14.09.2016, Revised-25.09.2016

Abstract: An experiment was conducted to assess the effect of various doses of GA_3 and NAA on growth, flowering, yield and yield contributing parameters in cucumber. Total eight treatments of the growth regulators viz, GA_3 10, GA_3 20, GA_3 30 ppm, NAA 50, NAA 100, NAA 150 ppm, GA_3 20 + NAA 100 and control were tried in Randomized Block Design and replicated thrice. Out of these, an application of combined dose @ GA_3 20 ppm + NAA100 ppm was found significantly superior in terms of growth, flowering and yield and yield attributing parameters i.e. vine length plant^{-1} (cm), number of primary branches plant^{-1}, number of leaves plant^{-1}, length and width of longest leaf (cm), days to first flower formation, number of male and female flower plant^{-1}, sex ratio, number of fruits plant^{-1}, length and width of fruit (cm) at alternate days, length and width of fruit (cm) at five days, weight of fruit^{-1}, fruit yield plant^{-1}, fruit yield plot^{-1} and yield (qha^{-1}) as compared to control and other applied treatment. Overall the impact of above observation, the highest yield (173.60 qha^{-1}) of tender green was recorded with a combined dose of GA_3 20 ppm + NAA100 ppm and minimum yield (150.53 qha^{-1}) of tender green under control.

Keywords: Cucumber, Pusa Uday, GA_3, NAA

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a widely cultivated and used by every class of people in day to day life in their diet. It is a monoecious creeper is a nutritious and delicious vegetable of tropical part of the world (Bailey, 1969). It belongs to family cucurbitaceae and having chromosome number 2n= 14. It contributes in vegetable production due to the number of vegetables are prominent members of this family. Cucumber exhibits a fascinating range of floral morphology, including staminate, pistillate and hermaphrodite flowers occurring in various arrangements and expressed various types of flowers. Likewise, maleness is one of the major problems in cucumber production which significantly reduce the fruit yield. The tender green fruits of cucumber are used as salad, pickle, culinary purposes and known as super food in recent days. Now-a-days, it is widely used to manufactures various cosmetics items like face cream, face wash, shampoo etc. The cucumber peel contains caffeic acid and ascorbic acid for maintaining healthy skin, relieving irritation and reducing inflammation in human being. In recent years, plant growth, flowering and yield have been manipulated with the help of growth regulating substances. Among the plant growth regulators, GA_3 and NAA have a great importance on sex modification in various cucurbitaceous crops Hilli, *et al*., 2010**.** Exogenous application of plant growth regulators can alter the sex ratio and sequence, if applied at the two and four leaf stage, which is the critical stage at which the suppression or promotion of either sex is possible (Hossain, *et al*., 2006). The sex expression of cucumber is also determined by genetics as well as environment (e.g. photoperiod, temperature etc.). Besides the environmental factors, endogenous levels of auxin and gibberellins at a time and the set of ontogeny determine the sex ratio and sequence of flowering (Dey *et al*., 2005). Moreover, the appearance of first staminate flower is delayed and pistillate flower initiation is promoted by relatively low concentrations of GA_3 Wang and Zeng, 1997). Though, the plant growth regulators have to be judiciously planned in terms of optimal concentrations, stage of application, species specificity and seasons, which constitute the major impediments in plant growth regulators applicability. In recent years, plant growth regulators play an important role to modify morphology and physiology of the plants. PGRs influence the plant growth; morphogenesis and yield have been manipulated. They should be applied in optimal concentrations, stage of application, species specificity, seasons etc. accurately Birader and Navalagatti, (2008). PGRs such as auxin and gibberellins include many aspects of plant growth and development. They are organic substances that are used in low concentration to change the plant growth usually by stimulating part of the natural growth regulatory system. Keeping this in view, the research work was undertaken to study the effect of different levels of auxin and gibberellins on growth, flowering and yield of cucumber (*Cucumis sativus* L.).

MATERIAL AND METHOD

The present investigation was carried out at Horticultural Research Centre, SVPUAT, Meerut,

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during 2014. The experiment was laid out in Randomized Block Design with total eight treatments *i.e.* GA_3 10ppm, GA_3 20ppm, GA_3 30 ppm, NAA 50ppm, NAA 100ppm, NAA 150 ppm, GA_3 20 ppm+ NAA 100 ppm and control (distilled water spray). The treatments were replicated thrice in experimental design. The soil of experimental plot was sandy loam with moderate fertility. The pH of soil was 7.8 in experimental plot. The seed of Pusa Uday cultivar of cucumber was taken and sown in experimental field. It was released by State Variety Release Committee, Delhi as proposed by Indian Agriculture Research Institute, New Delhi-12. The seeds were sown in field at a spacing of 1.25 m x 0.65 m. The recommended dose of manure and fertilizers @ 15 tones FYM + 40: 50: 50 kg N P K ha^{-1} was incorporated in experimental plots. The full dose of FYM was applied at the time of final preparation of field. The half dose of nitrogen, full dose of phosphorous and potash were supplied at the time of seed sowing and remaining half dose of nitrogen was applied before flowering. During the cropping period, all the cultural practices were done at regular intervals with the requirement of crop. Similarly, plant protection measures were also done with spraying fungicides and insecticides. Thereafter, data were recorded from randomly selected plants in each treatment and statically analysed by using statistical method as suggested by Gomez and Gomez (1996).

RESULT AND DISCUSSION

Effect of GA_3 and NAA on growth parameters

All the growth parameters such as length of main vine $plant^{-1}$, number of primary branches $vine^{-1}$, length of leaves and width of leaves were variably affected by the application of various plant growth regulators *i.e.*, GA_3 and NAA (Table 1). The experimental results revealed that all the growth parameters were significantly improved by using lower to higher concentration of GA_3, whereas, NAA was markedly unfavourable in respect of growth parameters with each increasing dose. However, a combined dose of GA_3 + NAA was found superior over the control and other treatments during experimentation.

In reference to vine length, the maximum vine length (155.28 cm) $plant^{-1}$ was recorded with an application of (GA_3 20 ppm+ NAA 100 ppm), followed by GA_3 30 ppm (153.02cm), GA_3 20ppm (151. 48cm), while minimum (138.08 cm) vine length $plant^{-1}$ was recorded in control. It might be due to their stimulatory effect on plant growth by cell elongation and rapid cell division in apical parts of plant. There are numerous reports showing that gibberellins and NAA promotes growth of intact plants. These results are in close conformity with the earlier findings of Chovatia, *et al.* (2010) and Sure, *et al.* (2013). Similarly, the average maximum number of branches (4.66) $plant^{-1}$ was observed with combined dose (GA_3 20 ppm+ NAA 100 ppm), followed by GA_3 30 ppm (4.41), GA_3 20 ppm (4.16) and minimum (2.41) under control followed by NAA 150 ppm (3.00) and NAA 100 ppm (3.25). The main vine and number of primary branches formed in plant are directly proportional to each other *i.e.* increase in main vine length resulting increase in number of primary branches and vice versa. The significant result might be due to reversible effect in terms of mitosis in plants due to the GA_3 and NAA application as a result of more number of primary branches on main branches of cucumber. Therefore, more length of vine causes more number of primary branches by use of combined dose of GA_3 20 ppm + NAA100 ppm. Similar findings were also given by workers Rafeekar, *et al.* (2001), Chovatia, *et al.* (2010) and Sure, *et al.* (2013).

The number of leaves $plant^{-1}$ significantly differed with in all applied treatments and considerably augmented due to the combined application of plant growth regulators at all the successive stages of growth. The experimental results exposed that the maximum number of leaves (99.16) were noticed with combination (GA_3 20ppm+ NAA 100ppm), while lowest number of leaves (84.44) $plant^{-1}$ were counted under control. Leaves plays an important role in different metabolic activity occurred in plant like photosynthesis, respiration, transpiration and translocation of nutrients. The augmentation in terms of number of leaves might be due to its additional availability of gibberellins in seed, which might have increased the level of amylase in the aleurone tissues of seed for better conversion of complex starch into sugars for energy to growth. These internal activities are responsible for more number of leaves formed in cucumber. The present findings of study are in close conformity with the earlier results of Batlang, *et al*., (2006), Hidayatullah, *et al.* (2012), and Imamsaheb and Hanchinmani, (2014).

In other hand, leaf dimension is another growth parameter for favourable flowering and yield of tender green fruit. According to data obtained in reference to length and width of longest leaf, the maximum leaf length (13.73cm) was observed with the combined foliar application of (GA_3 20 ppm + NAA 100 ppm) followed by GA_3 30 ppm (13.32cm) and GA_3 20 ppm (12.70cm), whereas minimum length of leaf (10.22cm) was measured in control. However, NAA was gave a markedly detrimental effect on length of longest leaf as compared to GA_3. It might be due to the gibberellins and auxin stimulated cell division and cell elongation, therefore the combining foliar spray of these growth substances in the present study significantly increases the leaf length in cucumber. Similarly, the maximum leaf width (9.64cm) was measured with an application of a combined dose of (GA_3 20ppm+ NAA 100ppm) followed by GA_3 30 ppm (9.24cm) and GA_3 20 ppm (8.66cm) and minimum leaf width

(6.92cm) under control. In other head, NAA showed a decreasing trend in width of leaf when applied alone. It might be due to the plant receive optimum level of gibberellins and auxin combined, resulting significant improvement in cell division and cell elongation. Therefore, width of longest leaf was significantly improved in cucumber. Similar results were also reported by earlier workers (Batlang, *et al.* 2006).

Effect of GA_3 and NAA on sex expression

Data articulated in Table-1 showed that the flowering behaviour and sex expression in cucumber were influenced by various doses of GA_3 and NAA in combination and alone. The significant effect was noted in the terms of days to first flower formation, number of male flower plant^{-1}, number of female flower plant^{-1} and sex ratio (Male: Female flower) during the experimental year. The response of different treatments on days required for appearance of first flower formation (male/female) significantly differed among all the treatments, combined dose (GA_3 20 ppm+ NAA 100 ppm) was found to be most effective in reducing number of days (34.85 days) required for appearance of first flower formation, which was followed by GA_3 10 ppm (35.79 days) and GA_3 20 ppm (36.58), while maximum time taken for flowering under control (44.27 days) followed by GA_3 30 ppm (42.74 days) and NAA 50 ppm (40.45 days). The favourable results were obtained as the gibberellins induces early flowering in lower concentration, while auxin like NAA delayed the flowering with lower doses as compared to higher doses of NAA. Therefore, the combined application of gibberellins and auxin gave the early flowering as compared to when applied alone. Early flowering of treated plants may be due to induction of tendency of femaleness in the plant and increased levels of auxin might have resulted in the early induction of flowers. Similar findings were obtained by Jadav *et al.* (2010), and Mia *et al*. (2014). Similarly, the minimum number of male flower (46.09 days) were produced in plants sprayed with combined dose of (GA_3 20ppm+ NAA 100ppm) followed by GA_3 10 (47.19 days) ppm, GA_3 20 (49.09 days) ppm and NAA 150 ppm (58.5 days), whereas maximum male flower (106.18 days) plant^{-1} were recorded under control followed by GA3 30 ppm (92.42 days), NAA50 ppm (77.57 days) and NAA 100 ppm (73.15 days). The positive response of growth regulators with combination was observed as compared to when applied alone. Growth promoters (GA_3 and NAA) reduced the male flower initiation with the optimum doses in the present study which might be because of the fact that they are at optimum level known to decrease the metabolization of photosynthates. Similar results were also earlier reported by Das *et al*. (2001) and Chovatia *et al.* (2010).

In present investigation, different doses of GA_3 and NAA were gave a significant response in terms of number of female flower plant^{-1} in cucumber. The maximum number (27.70) of female flowers were examined in treatment like GA_3 20 ppm + NAA 100 ppm followed by GA_3 10 (26.59) ppm and GA_3 20 (26.26) ppm, while minimum number of female flowers (19.31) were counted under control followed by GA_3 30 ppm (24.21) and NAA 50 ppm (25.28). It was also noted that each increment in NAA doses gave marked increase in number of female flowers plant^{-1}. It might be due to GA_3 and NAA induces femaleness in cucurbits and regulate the metabolic activities in plants. These results are in conformity with the findings of Dixit *et al.* (2001) and Craita and Tom, (2013). Data clearly indicated that the response of different growth regulators i.e. GA_3 and NAA to male: female sex ratio significantly differed. Among all the treatments, a combined dose of (GA_3 20ppm+ NAA 100ppm) was proved best for maintaining sex ratio followed by GA_3 10 ppm and GA_3 20 ppm as compared to controls other treatments. The maximum male: female ratio (3.81) was recorded with control, while minimum male: female ratio (1.65) was found with a combined dose of GA_3 20 ppm + NAA 100 ppm during investigation. Combined application of GA_3 and NAA at optimum doses could be attributed to the suppression of staminate flowers and promoted more number of pistillate flower. The narrower sex ratio by the combined application of NAA and GA_3 is possibly due to the fact that these substances are reported to increase functional female organs and compatibility besides reducing the embryo abortion in plants. Similar results were obtained earlier by Jennifer and Carol (2007) and Gill *et al.* (2012) in cucumber.

Effect of GA_3 and NAA on Yield and yield attributing parameters

Data pertaining from the Table-2 showed that the various doses of GA_3, NAA and combined application were gave a significant influence in terms of yield and yield attributing parameters as compared to control during experimentation. In present table data clearly indicated that the lower concentration of GA_3 was significantly improved regarding yield contributing parameters with the comparison of further higher doses of GA_3, whereas NAA also gave a similar results in increasing trend with lower to higher dose of NAA. Obviously, a combined dose of GA_3 + NAA was found significantly superior than control and other applied treatments on yield and yield attributing characters during course of investigation. The maximum number of fruits plant^{-1} (10.34) were recorded with combined application of (GA_3 20ppm+ NAA 100ppm) followed by GA_3 10 ppm (9.91) and GA_3 20ppm (8.62) in cucumber, whereas lower number of fruits plant^{-1} (5.25) were recorded under control followed by GA_3 30 ppm (6.35) and NAA 50 ppm (6.82). The significant improvement in fruit formation might be due to growth regulators increases the metabolic activity of

plant, which resulted in enhancement of reproductive phase in cucumber. These results are in close conformity with the findings of Hossain *et al.* (2006). Results clearly indicated that the maximum fruit length (11.59 cm) was measured in treatment like combined foliar application of GA_3 20 ppm + NAA 100 ppm followed by GA_3 10 (11.47cm) and ppm GA_3 20 ppm (11.45) in cucumber, while minimum fruit length (10.78 cm) was found under control followed by GA_3 30 ppm (10.85), NAA 50 ppm (11.39 cm), NAA 100 ppm (11.39 cm) and NAA 150 ppm (11.43 cm) at alternate day. However, non significant results were found in terms of width of fruit at alternate day in all the treatments during investigation. Similarly, the beneficial effect of GA_3 and NAA on length and width of fruits at five days were also found. The maximum length (15.58cm) and width (5.17 cm) of fruits were recorded with an application of GA_3 20 ppm + NAA 100 ppm, whereas, minimum length (14.89cm) and width (4.58cm) of fruits were recorded under control at five day. It may be explained as that sole function of fertilized ovules or seeds in relation to growth of fruit are to synthesize one or more hormone, which initiate and maintain a metabolic gradient along with food that can be transferred from parts of plants towards the fruits. The findings obtained here have confirmed the findings of Prabhu and Natarajan (2006). Similarly, the maximum fruit diameter (5.17cm) was recorded with the combined foliar application of both GA_3 20 ppm + NAA 100 ppm followed by GA_3 10 ppm (5.15 cm) GA_3 20 ppm (5.12) in cucumber. The diameter of fruit may be owing to the enlargement of cells. The elongation of cells of the fruit by auxin is diametric leading to the simultaneous increase in fruit diameter in bottle gourd. The similar results were obtained by Dostogir *et al*. (2006).

Present findings in relation to weight of fruit^{-1} were significantly affected by various doses of gibberellins and auxin as compared to control and other doses. The maximum weight of fruit^{-1} (220.35 g) was produced by the application of a combined dose of GA_3 20 ppm + NAA 100 ppm followed by GA_3 10 ppm (217.74 g), GA_3 20 ppm (215.27 g) and NAA150 ppm (214.67 g), while minimum weight of fruit^{-1} (209.26 g) was measured under control followed by GA_3 30 ppm (211.46 g) and NAA50 ppm (212.74 g). Similarly, the maximum yield of fruit plant^{-1} (2.27 kg) was found with the combined dose of GA_3 20 ppm + NAA 100 ppm followed by GA_3 10 ppm (2.15 kg), GA_3 20 ppm (1.85 kg) and NAA150 ppm (1.69 kg), whereas minimum yield of fruit plant^{-1} (1.09 kg) was obtained under control followed by GA_3 30 ppm (1.34 kg), NAA50 ppm (1.44 kg) and NAA 50 ppm (1.52 kg). The impact of above results also favoured the yield of tender green cucumber in terms of fruit yield plot^{-1} during investigation. The highest fruit yield plot^{-1} (22.76 kg) was estimated with an application of GA_3 20 ppm + NAA 100 ppm and lowest fruit yield plot^{-1} (10.96 kg) recorded under control. Data clearly pointed out in the Table-2 in perspective of cucumber yield and observed that the application of different growth regulators *i.e.* GA_3 and NAA significantly improved the yield of tender green cucumber as compared to control. The maximum fruit yield (173.6 qha^{-1}) of cucumber was recorded with an application of combined foliar application of GA_3 20 ppm + NAA 100 ppm followed by GA_3 10 ppm (168.20 qha^{-1}) and GA_3 20 ppm (165.66 qha^{-1}), whereas minimum fruit yield (150.53 qha^{-1}) was recorded in control followed by GA_3 30 ppm (155.63 qha^{-1}), NAA 50 ppm (158.70 qha^{-1}) during experimentation. An increase in fruit yield in treated plants may be attributed to the reason that plants remain physiologically more active to build up sufficient source for the developing flowers and fruits, ultimately leading to higher yield Imamsaheb and Hanchimani, (2014). Similar results were also reported by Dostogir *et al*. (2006), Jadav *et al.* (2010), Kalantar *et al.* (2008) and Mia *et al.* (2014).

Table 1. Effect of different doses of GA_3 and NAA on growth and flowering behaviour in cucumber

Treatments	Vine length (cm)	Number of leaves Plant^{-1}	Number of primary branches plant^{-1}	Length of longest leaf (cm)	Width of longest leaf (cm)	Days to first flower formation	Number of male flower plant^{-1}	Number of female flower plant^{-1}	Sex Ratio (Male : Female flower)
GA_3 10 ppm	150.34	95.10	3.91	12.30	8.20	35.79	47.19	26.59	1.77
GA_3 20 ppm	151.48	96.60	4.16	12.70	8.66	36.58	49.09	26.26	1.87
GA_3 30 ppm	153.02	97.72	4.41	13.32	9.24	42.74	92.42	24.21	3.81
NAA 50 ppm	147.94	93.00	3.50	11.81	7.78	40.45	77.57	25.28	3.06
NAA 100 ppm	146.65	90.94	3.25	11.55	7.49	39.15	73.15	25.61	2.85
NAA 150 ppm	144.61	90.04	3.00	11.27	7.22	38.83	58.50	25.85	2.26
GA_3 20 + NAA	155.28	99.16	4.66	13.73	9.64	34.85	46.09	27.70	1.65

100 ppm									
Control	138.08	84.44	2.41	10.22	6.92	44.29	106.18	19.31	5.49
S.E.m ±	0.36	0.75	0.12	0.09	0.08	0.44	0.94	0.08	0.04
C.D. 5 %	1.11	2.27	0.37	0.27	0.25	1.35	2.85	0.26	0.13

Table 2. Effect of different doses of GA_3 and NAA on yield and yield attributing parameters in cucumber

Treatments	Number of fruits plant^{-1}	Fruit length (cm) at alternate days	Fruit width (cm) at alternate days	Fruit length (cm) at five days	Fruit width (cm) at five days	weight of fruit^{-1} (g)	Fruit yield plant^{-1} (Kg)	Fruit yield plot^{-1} (Kg)	Yield (qha.$^{-1}$)
GA_3 10 ppm	9.91	11.47	4.95	15.47	5.15	217.74	2.15	21.53	168.20
GA_3 20 ppm	8.62	11.45	4.92	15.35	5.12	215.27	1.85	18.50	165.66
GA_3 30 ppm	6.35	10.85	3.61	14.97	4.91	211.46	1.34	13.4	155.63
NAA 50 ppm	6.82	11.37	3.67	15.13	4.95	212.74	1.44	14.46	158.70
NAA 100 ppm	7.14	11.39	4.81	15.16	5.02	213.23	1.52	15.20	161.70
NAA 150 ppm	7.92	11.43	4.84	15.28	5.09	214.67	1.69	16.93	163.66
GA_3 20 + NAA 100 ppm	10.34	11.59	4.98	15.58	5.17	220.35	2.27	22.76	173.60
Control	5.25	10.78	3.51	14.89	4.58	209.26	1.09	10.96	150.53
S.E.m ±	0.05	0.03	0.01	0.01	0.01	0.10	0.01	0.12	0.13
C.D. 5 %	0.17	0.10	NS	0.05	0.03	0.33	0.03	0.38	0.40

CONCLUSION

On the basis of results obtained from the present study concluded that the effect of the plant growth regulators on growth, flowering and yield in cucumber cv. Pusa Uday were gave significant effect as compared to control and other treatments. Among all the treatments, a combined dose of foliar application of GA_3 20ppm + NAA 100 ppm was found to most suitable for enhancing growth, flowering behaviour and tender green fruit yield.

REFERENCES

Batlang, U., Emongor, V.E., and Meulenburg, P.F. (2006). Effect of benzyl adenine plus gibberellins and gibberellic acid on yield and yield components of cucumber (*Cucumis sativus* L. cv. Tempo). *Journal of Agronomy*. 5(3): 418-423.

Bailey, L.H. (1969). Manual of cultivated plants. *Macmillan Company, New York*. 1. pp. 116.

Birader, G. and Navalagatti, C.M. (2008). Effect of plant growth regulators on physiology and quality in bitter gourd (*Momordica charantia*). M.Sc. thesis, University of Agricultural Sciences, Dharwad.

Chovatia, R.S., Ahlawat, T.R., Kavathia, Y.A., Jivani, L.L. and Kaila, D.C. (2010). Effect of plant growth regulators on vegetative, flowering and yield of bitter gourd cv. Priya. *Indian J. Hort.*, 67: 254-256.

Craita, E. B. and Tom, G. (2013). Plant tolerance to high temperature in a changing environment: Scientific Fundamentals and Production of Heat stress-Tolerant Crops. *Front Plant Science*. 4: 273.

Das, R., Rabha, B.K., and Dey, S.C. (2001). Effect of growth regulators on sex expression and fruit yield in cucumber (*Cucumis sativus* L.) under plastic greenhouse. *Annals of Agricultural Research.* 22(3): 312-317.

Dey, S.S., Batters, T.K., Pal, A. and Munshi, A.D. (2005). Correlation and path coefficient analysis in bitter gourd (*Momordica charantia* L.). *Vegetable Science*, 32: 173-176.

Dixit, A., Rai, N. and Kumar, V. (2001). Effect of plant growth regulators on growth, earliness and sex ratio in watermelon under Chhattisgarh region. *Indian Journal of Agricultural Research.*, 35: 173-176.

Dostogir, H., Karim, A., Rahman, H., Pramanik, M. and Rahman, A. A. M. (2006). Effect of gibberellic acid (GA_3) on flowering and fruit development of bitter gourd (*Momordica charantia* L.). *Intl. J. Bot.*, 2 (3): 329-332

Gomez, A. K. and Gomez, A.A. (1996). Statistical Procedure for Agriculture Research, John Willey and Sons Pnc, New York.

Gill, J., Dhillon, W.S., Gill, P.P.S. and Singh, N. (2012). Fruit set and quality improvement studies on bitter gourd. *Indian Journal of Horticulture,* 69 (1): 39-44.

Hidayatullah, M.T., Farooq, M., Khokhar, M.A. and Hussain, S.I. (2012). Plant growth regulators affecting sex expression of bottle gourd (*Lagenaria siceraria* Molina) plant. *Pakistan Journal of Agric. Res*., 25(2):173-178

Hilli, J. S., Vyakarnahal, B. S., Biradar, D. P. and Ravi, H. (2010). Effect of growth regulators and stages of spray on growth, fruit set and seed yield of ridge gourd (*Luffa acutangula* L. Roxb). *Karnataka Journal of Agricultural Sciences*. 23(2): 239-242.

Hossain, D., Karin, M.A., Pramani, M.H.R. and Rehman, A.A.S. (2006). Effect of foliar application of IAA and GA_3 on sex expression, yield attributes and yield of bitter gourd (*Momordica charantia* L.). *Journal of Biological Sciences.*, 5: 55-62.

Imamsaheb, S.J. and Hanchinmani, C.N. (2014). Effect of different levels of fertilizers and growth regulators on growth, yield and economics of bitter gourd under north-eastern transition zone, *Plant Archives.* 14 (2): 871-874

Jadav, R.G., Patel, T.V., Parmar, A.B. and Saiyad, M.Y. (2010). Sex modification of cucumber vegetable through PGRs. *Journal of Pure Appl. Sci.*, 18: 13-14.

Jennifer, J. W. and Carol, G. (2007). Timing of self-compatibility, flower longevity, and potential for male outcross success in long melon. *East Carolina University, Department of Biology, Greenville, North Carolina* 27858 USA.

Kalantar, M., Khalighi, A., Hassanpour, A. and Tafazoli, E. (2008). Effect of plant growth regulators and planting systems on yield components of hybrid cucumber (*Cucumis sativa* L. cv. Melita). *Persian Journal of Research in Agricultural Science*, 4(2):214-224.

Mia, B.M.A., Islam, M.S., Miah, Y.M., Das, M.R., and Khan, H.I. (2014). Flower synchrony, growth and yield enhancement of small type bitter gourd (*Momordica charantia* L.) through plant growth regulators and NPK fertilization. *Pakistan Journal of Biological Science,* 17(3): 408-413.

Prabhu, M. and Natarajan, S. (2006). Effect of growth regulators on fruit characters and seedlessness in ivy gourd (*Coccinia grandis* L.). *Agric. Sci. Digest.*, **26**(3): 188-190.

Rafeekher, M., Gondane, S.U., Sorte, P.N. and Goramnagar, H.B. (2001). Effect of foliar spray of growth regulators on growth, sex expression and yield of cucumber. *Annals of Plant Physiology*, 15 (1):1-5

Sure, S., Arooie, H. and Azizi, M. (2013). Effect of GA_3 and Ethephon on sex expression and oil yield in medicinal pumpkin (*Cucurbita pepo* var. *Styriaca*). *International Journal of Farming and Allied Sciences.* **2** (9): 196-201.

Wang, Q.M. and Zeng, G.W. (1997). Morphological and histo-chemical study on sex differentiation in *Momordica charantia*. *Journal of Zhejiang Agriculture University*, 23: 149-153.