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RESEARCH ARTICLE

SEX MODIFICATION IN CUCUMBER (*CUCUMIS SATIVUS* L.) UNDER THE INFLUENCE OF ETHEPHON AND MALEIC HYDRAZIDE.

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Abstract

The present study was conducted to study the effect of foliar application plant growth regulators i.e. maleic hydrazide and ethephon on vegetative growth, sex expression, fruit setting, and fruit yield of cucumber. The plant material included three cultivars of cucumber i.e. Poinsette, Punjab Naveen and Pant Khira 1 raised during summer season during 2014-2015. Growth regulators ethephon and maleic hydrazide were sprayed at different concentrations on two and four leaf stage. Foliar application of Ethephon application @ 200 ppm reduced the vine length to the maximum, but it improved the number of secondary branches and fruit weight per vine. Application of Maleic hydrazide and ethephon application @ 100 ppm led to early production and yield of cucumber. The investigation concludes that foliar application of maleic hydrazide and ethephon can help promote feminism and increase the yield of cucumber crop.

Introduction:-

The role of plant growth regulators has been well known to modify various physiological processes in cucurbitaceous crops (Thomps 2008), among them sex modification is well studied under the influence of growth regulators (Lal and Jaiswal, 1988). The ealier studies reveal production of female flowers in low temperature and short days (Nitsch 1965). Lal and Jaiswal, (1988) which suggest the synthesis of phytohormones in plant body. Keeping in view the fact exogenous application of growth regulators has been extensively studied to modified sex expression in favors of feminism under the influence of growth regulators i.e. ethephon and maleic hydrazide when applied at two and four leaf stage (Hossain et al., 2006). By endogenous level of various growth hormones, sex expression in cucumber is affected which can be triggered with the exogenous application of growth regulators (Singh and Singh, 1988). The present study was thus undertaken to study the effect of exogenous application of ethephon and maleic hydrazide for increasing the number of pistillate flowers, so as to improve the yield of cucumber

Methodology:-

The present investigation was carried out in cucumber on cultivars, Poinsette, Punjab Naveen and Pant Khira-1 at Vegetable Research Farm, Department of Vegetable Science, Punjab Agricultural University (PAU), Ludhiana during summer season of 2014 and 2015. The study was carried out in a split plot design with different cultivars in main plot while doses of growth regulators were in sub plots replicated thrice, sub plot treatment comprised growth regulators i.e. maleic hydrizide and ethephon at variable concentrations i.e. 20,100,150 and 200 ppm along with

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distilled water as control. The stock solutions of 1000 ppm were prepared fresh at the time of each spraying and diluted as per required concentrations in the field. The growth regulators were laboratory research from Loba Chemie PVT Ltd., Mumbai, India. During both the years the sowing of nursery was sown in the last week of February under protected conditions in poly-bags of size 15× 10 cm and transplanted in the last week of March. The seedlings were transplanted on 2.5 metres wide beds on both sides with intra row spacing of 60 cm. The crop was sprayed at two and four leaf stage with hand spray. The adjoining plots were covered with plastic sheet to avoid drift of the chemical. The sex of each flower was identified on the day of anthesis day. Both the staminate and pistillate flowers showed normal growth and no abnormal flowers were observed in any treatment. The data obtained from the experiments were subjected to statistical analysis as suggested by Steel and Torrie (1981).

Results and Discussion:-

Vegetative growth:-

Growth regulators are reported to have stimulatory effect on vegetative growth in cucumber. The present study revealed non significant differences among the cultivars of cucumber during both the years of investigation for vine length and number of secondary branches (Table 1). The vine length is attributed to the genotypic potential of the cultivars. The further investigation of the data revealed significant effect of the growth regulators on vine length of different cultivars of cucumber. The vines recorded maximum length when those were not sprayed with any growth regulator. Vines recorded average vine length of 2.70 metres and 2.64 metres, respectively during 2014 and 2015. The foliar application of both the growth regulators i.e maleic hydrazide and ethephon led to reduced vine length at all rates. It was seen that there was linear decrease in vine length with every dose of maleic hydrazide and ethephon. Minimum vine length of 2.21, 2.19 and 2.25, 2.23 meter were recorded with the foliar application of maleic hydrazide and ethephon respectively @ 200 ppm during 2014, 2015, respectively. The reduction in vine length is attributed to reduction in cell division and cell expansion. Mishra and Sharma (1965) recorded significant reduction in elongation of internodes and nodes with foliar application of maleic hydrazide @ 200 ppm. Das (1978) reported that maleic hydrazide foliar application inhibits terminal plant growth, stem elongation and apical dominance in most of the cucurbits. Like maleic hydrazide, application of ethrel at the rate of 200-500 ppm led to reduction in vine length in watermelon (Singh and Madan 1971). In ridge gourd, application of ethrel @ 250 ppm reduced the vine length (Patnaik *et al.*, 1974).

Table 1:- Effect of plant growth regulators on vine length (m) and number of secondary branches.

	Vine length (m)								Number of Secondary branches							
	2014				2015				2014				2015			
Grwth regulators (ppm)	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**
MH 50	2.44	2.47	2.50	**2.47**	2.36	2.45	2.46	**2.42**	12.70	12.60	12.62	**12.64**	12.66	12.72	12.67	**12.68**
MH 100	2.41	2.36	2.32	**2.36**	2.26	2.29	2.33	**2.29**	13.32	13.43	13.26	**13.34**	13.41	13.58	13.21	**13.40**
MH 150	2.24	2.30	2.26	**2.27**	2.27	2.31	2.25	**2.28**	13.43	13.42	13.45	**13.43**	13.47	13.44	13.44	**13.45**
MH 200	2.20	2.23	2.21	**2.21**	2.22	2.28	2.25	**2.25**	13.75	13.68	13.89	**13.77**	13.93	13.85	14.23	**14.00**
ET 50	2.40	2.39	2.39	**2.39**	2.42	2.39	2.45	**2.42**	13.00	13.08	13.15	**13.08**	13.11	13.16	13.16	**13.14**
ET 100	2.32	2.37	2.37	**2.36**	2.43	2.40	2.37	**2.40**	13.25	13.45	13.30	**13.33**	13.29	13.27	13.29	**13.28**
ET 150	2.31	2.28	2.29	**2.29**	2.30	2.27	2.32	**2.30**	13.21	13.40	13.42	**13.34**	13.40	13.37	13.40	**13.39**
ET 200	2.21	2.17	2.20	**2.19**	2.21	2.23	2.25	**2.23**	14.12	13.84	14.04	**14.00**	13.56	13.65	13.59	**13.60**
Control	2.69	2.72	2.68	**2.70**	2.69	2.64	2.60	**2.64**	12.30	12.25	12.23	**12.26**	12.24	12.20	12.23	**12.22**
Mean	**2.36**	**2.37**	**2.36**		**2.35**	**2.36**	**2.36**		**13.23**	**13.24**	**13.26**		**13.23**	**13.25**	**13.25**	

L.S.D(P=0.05)		**2014**	**2015**		**2015**	**2014**
	Varieties (Var)	NS	NS	**Varieties (Var)**	NS	NS
	Growth Regulators (GR)	0.42	0.44 **L.S.D(P=0.05)**	**Growth Regulators (GR)**	0.52	0.43
	Var×GR	NS	NS	**Var×GR**	NS	NS

On the other hand, the non significant difference for branching is attributed to the genetic constitution of the cultivars. It was further seen from the data that number of branches were minimum when these were not sprayed with any growth regulator. It recorded a number of 12.26 and 12.22 during 2014 and 2015 respectively. Foliar application of both the growth regulator at two and four leaf stage encouraged the branching of cucumber. Application of maleic hydrazide and Ethephon @ 200 ppm recorded the maximum number of branches among all the treatments. Maximum number of branches were recorded with the application of maleic hydrazide and ethephon. It recorded a number of 13.77 and 14.00 with maleic hydrazide and ethephon @ 200 ppm respectively during 2014. More number of branches with higher dose of growth regulator is most probably due to reduced vine length which was depicted with profuse branching. Several workers have already reported profused branching in bottle gourd with foliar application of maleic hydrazide and ethephon @ 200 ppm (Robinson *et al.*, 1969 and Arora *et al.*, 1982). Likewise ethephon application is also known to induce branching in cucurbitaceous crops. Rafeekher *et al.*, (2002) recorded increase in number of branches in cucumber with foliar application of ethephon @ 250 ppm.

Sex expression:-

The plant growth regulators are reported to influence flowering and modification of sex expression especially sex ratio. In the study, flowering traits and sex expression of cucumber are reported in Table (2). The data presented depicts non significant differences among the cultivars for the appearance of male and female flowers during both the years of investigation where vines of all cultivars on an average took about 49-50 and 51 days approximately for the appearance of male and female flowers respectively. Monoecism is an important character for most of the cucurbitaceous crops which is evident in cucumber cultivars studied during both the years where female flowers appear about two to three days later than male flowers. It was further seen from the data that growth regulators significantly enhanced the female flower and delayed male flower appearance. It took 54.18 days and 53.86 days during 2014 and 2015, respectively for female flower, where no growth regulators were sprayed. The number of days taken for female flower appearance decreased with foliar application of maleic hydrazide and ethephon at two and four leaf stage. Minimum numbers of days were taken for the female flower appearance when crop was sprayed with the highest rate of either maleic hydrazide or ethephon @ 200 ppm. It took 49.97 days and 50.03 days, respectively during 2014 and 2015, respectively with foliar application of maleic hydrazide @ 200 ppm. Likewise, it took 50.84 and 51.05 days with foliar application of ethephon @ 200 ppm, respectively during both the years.

Table 2:- Effect of plant growth regulators on number of days taken to first staminate flowers and pistillate flowers.

	Number of days to first staminate flowers								Number of days to first pistillate flowers							
	2014				2015				2014				2015			
Grwth regulators (ppm)	Poinsette	Punjab Naveen	Pant Khira 1	**Mean**	Poinsette	Punjab Naveen	Pant Khira 1	**Mean**	Poinsette	Punjab Naveen	Pant Khira 1	**Mean**	Poinsette	Punjab Naveen	Pant Khira 1	**Mean**
MH 50	48.97	48.53	48.60	**48.70**	48.10	47.54	48.03	**47.89**	51.14	52.33	53.89	**52.45**	50.87	52.40	52.27	**51.85**
MH 100	50.03	49.33	49.40	**49.59**	50.54	51.59	48.97	**50.37**	50.50	51.13	51.17	**50.93**	51.27	52.59	51.13	**51.66**
MH 150	50.60	50.10	49.27	**49.99**	49.52	50.09	49.67	**49.76**	49.97	50.33	50.80	**50.37**	50.30	50.33	50.53	**50.39**
MH 200	51.80	50.77	53.50	**52.02**	50.96	50.78	53.50	**51.75**	49.90	50.00	50.00	**49.97**	49.16	50.98	49.94	**50.03**
ET 50	49.67	51.32	47.64	**49.54**	47.87	52.76	51.69	**50.77**	52.56	50.86	51.97	**51.80**	52.17	52.24	51.87	**52.09**
ET 100	50.07	49.10	49.27	**49.48**	49.75	49.37	49.43	**49.52**	52.54	51.53	53.95	**52.67**	51.53	51.43	51.70	**51.56**
ET 150	51.42	48.69	50.2	**50.11**	49.83	49.07	50.63	**49.84**	52.21	51.25	50.4	**51.30**	50.63	50.80	50.6	**50.70**

			3								3				7	
ET 200	51.89	50.47	49.50	**50.62**	50.47	50.77	49.83	**50.36**	50.58	51.78	50.17	**50.84**	52.94	50.07	50.13	**51.05**
Control	45.97	46.52	48.63	**47.04**	46.95	48.13	45.64	**46.91**	53.78	54.12	54.65	**54.18**	53.79	54.93	52.85	**53.86**
Mean	**50.05**	**49.43**	**49.56**		**49.33**	**50.01**	**49.71**		**51.46**	**51.48**	**51.89**		**51.41**	**51.75**	**51.23**	

L.S.D(P=0.05)		**2014**	**2015**	**L.S.D(P=0.05)**		**2014**	**2015**
	Varieties (Var)	NS	NS		**Varieties (Var)**	NS	NS
	Growth Regulators (GR)	0.38	0.72		**Growth Regulators (GR)**	0.39	0.37
	Var×GR	NS	NS		**Var×GR**	NS	NS

On the other hand it took 51-52 days for male flower to appear. The number of days taken for male flower appearance increased with foliar application of maleic hydrazide and ethephon of vines at two and four leaf stage. Maximum numbers of days were taken for the male flower appearance when crop was sprayed with the highest rate of either maleic hydrazide or ethephon @ 200 ppm. It took 52.02 days and 51.75. days, respectively during 2014 and 2015 with foliar application of maleic hydrazide @ 200 ppm. The present study finds the support of the work of Singh and Choudhary (1988) who noticed early appearance of female flowers in cucumber with the foliar application of maleic hydrazide @ 50 ppm and 100 ppm. The several workers also recorded early appearance of female flowers in cucumber and bottle gourd with foliar application of ethephon (Singh and Choudhary 1988). Suthar *et al.,* (2007) also noticed early production of pistillate flowers in cucumber. These results indicated that ethephon was more effective in female flower induction and confirmed results of other authors (Thomas 2008 and Yongan *et al.,* 2002). Different concentrations of ethephon had similar effects on female flower produced (Vadigeri *et al.,* 2001; Rudich *et al.,* 2004)

Fruit Yield:-

Yield in term of fruit weight per plant and total yield per hectare was higher in all treatments than control (Table 3). The data presented in Table 3 showed significant differences among the cultivars for fruit weight per plant and fruit yield. The fruit weight per vine was maximum in cultivar Punjab Naveen followed by Pant Khira 1 and Poinsette. The differences in fruit yield is due to genetic constitution of the cultivars. Further perusal of the data revealed significant effect of growth regulators on the fruit yield. The lowest fruit yield of 2.41 and 2.40 kg per vine was recorded during 2014 and 2015 where no growth regulator was applied. Whereas all the doses of growth regulators helped improve the fruit yield per vine where maximum fruit yield was recorded with the application of maleic hydrazide and ethephon each at the rate of 100 ppm. This observation correlates well with average fruit weight which was recorded maximum with the application of maleic hydrazide and ethephon @ 200 ppm. Increased fruit yield of cucumber has also been reported by Hidayatullah *et al*., (2012) in bottle gourd.

Table 3:- Effects of plant growth regulators on fruit weight per plant (kg) and total yield (q/ha).

	Fruit weight per plant(kg)								**Total yield (q/ha)**							
	2014				**2015**				**2014**				**2015**			
Growth regulators (ppm)	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**	**Poinsette**	**Punjab Naveen**	**Pant Khira 1**	**Mean**
MH 50	2.58	2.74	2.70	**2.68**	2.48	2.57	2.69	**2.58**	172.12	182.93	180.28	**178.44**	165.61	171.53	179.21	**172.12**
MH 100	2.97	3.00	2.80	**2.92**	3.06	2.91	2.90	**2.96**	197.99	199.80	186.32	**194.70**	203.97	193.99	193.52	**197.16**
MH	2.73	2.9	2.7	**2.80**	2.83	2.8	2.76	**2.**	182.	193.	18	**186.7**	188.	188.	183.7	**186.**

150		0	7			2		**80**	19	63	4.39	**4**	67	15	5	**85**
MH 200	2.76	2.81	2.89	**2.82**	2.69	2.85	2.89	**2.81**	184.11	187.54	192.94	**188.20**	179.60	189.79	192.80	**187.39**
ET 50	2.57	2.77	2.66	**2.67**	2.81	2.67	2.66	**2.71**	171.28	184.75	177.40	**177.81**	187.63	177.76	177.33	**180.90**
ET 100	2.99	3.19	2.69	**2.96**	3.10	3.10	2.81	**3.00**	199.54	212.65	179.33	**197.18**	206.59	206.97	187.05	**200.21**
ET 150	2.70	2.90	2.62	**2.74**	2.74	2.76	2.67	**2.72**	179.88	193.51	174.96	**182.78**	182.54	183.69	178.31	**181.51**
ET 200	2.92	3.05	2.86	**2.94**	2.91	2.90	2.77	**2.86**	194.52	203.31	190.97	**196.27**	194.22	193.11	184.61	**190.64**
Control	2.40	2.50	2.33	**2.41**	2.45	2.36	2.40	**2.40**	159.77	166.74	155.38	**160.63**	163.38	157.51	159.99	**160.29**
Mean	**2.74**	**2.88**	**2.70**		**2.79**	**2.77**	**2.73**		**182.38**	**191.65**	**180.22**		**185.80**	**184.72**	**181.84**	

L.S.D(P=0.05)	**2014**		**2015**		**2014**		**2015**	
	Varieties (Var)	0.71	0.53		**Varieties (Var)**	4.8	3.9	
	Growth Regulators (GR)	0.82	0.84	**L.S.D(P=0.05)**	**Growth Regulators (GR)**	5.51	5.65	
	Var×GR	0.14	0.10		**Var×GR**	9.55	9.78	

It was noticed that yield of cucumber was maximum in cultivar Punjab Naveen during both year followed by cultivars Poinsette and Pant Khira 1. The yield potential is dependent on the fruit number and their weight which were higher in Punjab Naveen. It was further seen from the data that foliar application of both the growth regulators influenced the fruit yield as compared to control. A minimum fruit yield of 160.63 and 160.29 q/ha was noticed during 2014 and 2015 respectively, when vines were not sprayed with growth regulators. However, yield record was maximum when vines were sprayed with maleic hydrazide or ethehon @ 100 ppm. This finding has close correlation with maleic hydrazide or ethephon where these treatments recorded maximum fruit weight. Beneficial effects of maleic hydrazide and ethephon have been reported to improve yield of cucumber. Murthy *et al.*, (2007) in gherkin also record similar results with the use of maleic hydrazide. The findings are supported with the work by Mollier (2010) was reported application of 100 ppm maleic hydrazide alongwith ethephon in cucumber. Likewise, Thappa *et al.*, (2011) recorded the highest fruit yield with the application of ethrel @ 100 ppm in cucumber. It was suggested by Ries (1985) that the application of growth retardants like maleic hydrazide increased the endogenous ethylene level which triggered metabolic processes and affected the C:N ratio in plants they stimulate flowering, fruit set, sex ratio and thereby yield.

Conclusion:-

However, the results of this study indicated that vegetative growth, flowing characteristic sex modification and yield were significantly affected by foliar application of maleic hydrazide and ethephon @ 100 ppm treatment. This treatment also gave the best economic result.

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