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Influence of different concentration of ethrel and NAA on yield and flowering parameters of cucumber cv. Pusa Sanyog

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Abstract
The field experiment on "Influence of different concentration of ethrel and NAA on yield and flowering parameters of Cucumber cv. Pusa Sanyog" was carried out at Polytechnic in Horticulture, ACH, NAU, Paria, Valsad, Gujarat (India) during summer season, 2019. The field investigation was laid out in Randomized Block Design (RBD) with three replications, which include seven Treatments namely, T_1: Ethrel @ 50 ppm, T_2: Ethrel @ 100 ppm, T_3: Ethrel @ 150 ppm, T_4: NAA @ 50 ppm, T_5: NAA @ 100 ppm, T_6: NAA @ 150 ppm and T_7: Control (No spray) to assess the response of various plant growth regulators on fruiting behaviour and yield of cucumber cv. Pusa Sanyog. The study revealed that an application of ethrel 150 ppm was found to be the most effective for maximum female flowers (29.58) per vine, induce female flower at lower node (3.67), lowering the male:female sex ratio (2.50) with increasing the numbers of fruits per vine (11.97), yield per plot (23.08 kg) and per hectare (35.62 t). All plant growth regulators concentrations failed to exhibit any noticeable effect on the duration of fruiting, fruit length and fruit weight. However, maximum duration of fruiting (49.97 days) and fruit weight (164.22 g) were recorded in treatment T_3 (ethrel @ 150 ppm), while maximum fruit length (14.70 cm) recorded in T_4 (NAA @ 50 ppm). Fruit diameter significantly influenced by all plant growth regulators concentrations and maximum fruit diameter (4.59 cm) recorded in T_3 (ethrel @ 150 ppm). From the results of the investigation, it is inferred that foliar spray of ethrel @ 150 ppm at two and four true leaf stages were the most effective for lowering M:F sex ratio (2.50) and higher yield (35.62 t ha^{-1}in cucumber *cv.* Pusa Sanyog under South Gujarat conditions.

Keywords: Concentration, ethrel, NAA, yield, flowering parameters, cucumber

1. Introduction
In India only round 230.4 g per day vegetable utilization and it is too low as compares to other countries (Singh, 2015) [14]. As majority of peoples of India are vegetarians, there for demand of vegetables production is high.
Among the vegetables, the crops of cucurbitaceae family are generally referred as 'cucurbits' which have about 118 genera with 825 species all over the word. While among all of them are derived from old world, many species among them are belonged to new world. The chromosome number of cucumber (*Cucumis sativus* L.) is about 2n = 2x = 14 and it is most important allogamus vegetable crop of cucurbitaceae family (Bailey, 1969) [1].
The PGRs (plant growth regulators) play a vital role when it applied at proper stage and concentrations for modifying sex appearance, which also help to improve yield in cucumber (Sircar, 1971) [18]. The effects of PGRs in cucumber display an attractive range of male, female and androgynous flowers occurring in various arrangements and yielding several types of sexual appearance. Development of different flower types in cucumber can be modifying by the use of PGRs like α-naphthalene acetic acid, ethephon, gibberellic acid and silver nitrate.

2. Materials and Methods
2.1 Location and Weather
The trial was carried out at Polytechnic in Horticulture, ACH, NAU, Paria, Valsad, which is situated on 22°35' North latitude and 72°35' East longitude at an elevation of 16.10 m above mean sea level. The meteorological data on maximum (37.39 °C) and minimum (18.42 °C) temperatures, minimum (47.91%) and maximum (60.55%) relative humidity and minimum sunshine hours per day (9.11) during investigation were recorded at Agriculture Experimental Station, Navsari Agricultural University, Village: Paria, Taluka: Pardi, District: Valsad for the period from February, 2019 to May, 2019.

2.2 Soil
Experimental soil is medium to very low permeable and alkaline in nature. Soil is low to medium nitrogen, phosphorus and potash content. Micro nutrient deficiency is negligible except Zn due to experimental farm located at costal area. The experimental trial top soil was deep black having excellent water holding capacity (WHC).

2.3 Experimental detail
The experiment trial was laid out in Randomized Block Design (RBD) with three replications, which included 7 treatments *viz.*, T_1 = Ethrel @ 50 ppm, T_2 = Ethrel @ 100 ppm, T_3 = Ethrel @ 150 ppm, T_4 = NAA @ 50 ppm, T_5 = NAA @ 100 ppm, T_6 = NAA @ 150 ppm, and T_7 = Control (No spray). The size of each plot was 5.4m × 3.0 m and total experimental area was 26 m x 20.2 m.
The required quantity of each of the ethrel and NAA was weighed separately, ethrel was prepared by adding distilled water just before application and NAA dissolved in 1N NaOH than added water for final volume. Stiker solution was added as a wetting agent.

2.4 Preparation of spray solution

Sr. No.	PGRs	Quantity	Calculation
1.	Ethrel	50 µl L^{-1}	50 µl Ethrel in 1 litre of water.
2.	Ethrel	100 µl L^{-1}	100 µl Ethrel in 1 litre of water.
3.	Ethrel	150 µl L^{-1}	150 µl Ethrel in 1 litre of water.
4.	NAA	50 mg L^{-1}	50 mg NAA in 1 litre of water.
5.	NAA	100 mg L^{-1}	100 mg NAA in 1 litre of water.
6.	NAA	150 mg L^{-1}	150 mg NAA in 1 litre of water.

Note: NAA dissolved in 1N NaOH before making final volume with water.

2.5 Statistical analysis and Observations
The data of all yield and flowering parameters are collected from five tagged plant and count average of five tagged plant, after that mean data was statistically analysis by technique as described by Panse and Sukhatme (1985). The Randomized Block Design (RBD) was used for experimental analysis of variance.

3. Results and Discussions
3.1 Influence of different concentration of ethrel and NAA on yield
The average data of all yield parameters are represented in Table 3.1

3.1.1 Days to first harvesting
Applying ethrel at the highest concentration *i.e.* 150 ppm (T_3) advanced the days for first harvesting (45.76) which was at par with T_2 (47.77), T_1 (49.12) and T_6 (49.03), where more days to first harvesting (54.87) observed in T_7 (control). With increased concentrations of ethrel reduced time for first harvesting. This may probably be due to the fact that the plants receiving treatments are able to build up suitable carbohydrate reserves resulting in early flowering as well as increased number of female flower and fruit set. Early female flower induction due to ethrel has been reported earlier by Kshirsagar *et al.* (1995) [7].

3.1.2 Duration of fruiting
The duration of fruiting was non-significantly influenced by different treatments. Maximum duration of fruiting (49.97 days) was observed in treatment T_3 (ethrel @150 ppm) and minimum duration of fruiting (42.20 days) in T_7 (control). This result similar with Kooner *et al.* (2000) [6].

3.1.3 Fruit length
Foliar spray of PGRs with different dilutions was not significantly affected on the fruit length. The maximum fruit length (14.70 cm) was noted in T_4 (NAA @ 50 ppm) while minimum fruit length (12.78 cm) recorded in treatment T_7 (control). The results was same with Vadigeri *et al.* (2001) [20].

3.1.4 Fruit diameter
The maximum fruit diameter (4.59 cm) was recorded in T_3 (ethrel @ 150 ppm) while minimum fruit diameter (3.45 cm) in T_7 (control). All the higher concentrations of ethrel and NAA non-significantly reduced the fruit length and increased fruit diameter. Reduction in fruit length and increased in fruit diameter due to ethrel treatment is attributed to anti-gibberellin activity. At cellular concentrations, ethylene induced swelling of etiolated tissue causing inhibition of cell division and alteration of cellular growth in the elongating region in which later cell expansion by ethylene is accomplished at the expense of longitudinal extension (Taiz, 1983) [19]. The increased in fruit diameter by ethrel as reported by Singh and Choudhary (1989) [17].

3.1.5 Fruit weight
The fruit weight was non-significantly influenced by different treatments. Maximum fruit weight (164.22 g) was observed in Treatment T_3 (ethrel @ 150 ppm) while, minimum fruit weight (152.72 g) was recorded in T_7 (control). Ethrel showed slightly more weight compared to other treatments. The maximum increased in starch and carbohydrates after treatments with ethrel (150 ppm) as reported by Singh and Singh (1984) [15].

3.1.6 Fruit yield (per vine, plot and hectare)
Number of fruits per vine, yield per plot and yield per hectare showed significant response to the application of plant growth regulators. Maximum number of fruits per vine (11.97), yield per plot (23.08 kg) and yield per hectare (35.62 t) were recorded in T_3 (ethrel @ 150 ppm), all of them remained at par with T_2 in terms of number of fruits per vine (11.24), yield per plot (21.40 kg) and yield per hectare (33.03 t). A sensible explanation for these results is that ethrel suppresses the number of male flowers and promotes the number of female flowers there by increasing the number of fruits and ultimately produced more yield. The above result are in consonance with the findings of Mehdi *et al.* (2012) [9] and Kshirsagar *et al.* (1995) [7] in cucumber and Chovatia *et al.* (2010) [2] in bitter gourd.

3.2 Influence of different concentration of ethrel and NAA on Flowering
The mean data regarding influence of different concentration of ethrel and NAA on flowering parameters are display in Table 3.2.

3.2.1 Node of first male and female flower appear
From data, it was evident that all the concentrations of plant growth regulators advanced the appearance of first male and female flower significantly on the on upper and lower nodes

respectively, as compared to control. Treatment T_3 (ethrel @ 150 ppm) showed significantly superior in advanced the appearance of first female flower node (3.67) and male flower node (3.27), whereas T_7 (control) showed female flower on upper node (5.80) and male flower on lower node. It may be due to the application of ethrel induced the transformation of male flower buds into female flowers. The maximum increased in starch and carbohydrate with ethrel treatments are reported by Singh and Singh (1984) [15]. Early appearance of female flowers on lower nodes and delayed induction of male flowers on upper nodes with different concentrations of ethrel is in confirmation with the results of Das *et al.* (1995) [3] and Kshirsagar *et al.* (1995) [7] in cucumber and Ranjit and Satya (2006) [13] in pumpkin.

3.2.2 Days to appearance of 50 percent male flowering

It is obvious from the data showed that the effect of plant growth regulators with varying concentrations were highly significant on the number of male flowers per vine. The minimum (74.13) number of male flowers per vine was observed in T_3 (ethrel @ 150 ppm), which was at par with T_2 (80.80). The maximum (101.53) number of male flowers per vine was noted in T_7 (control). The response of different treatments on days to appearance of 50 per cent male flowering differed significantly among all the treatments, the maximum days required for appearance of 50 per cent male flower (44.90) in T_7 (control). While, ethrel significantly hastened the period required for appearance of first male flower. The sexual differentiation is controlled by endogenous level of auxins in religions neighbouring the flowering primodia and during flowering the formation of staminate organs may be favoured by low concentrations in auxin in the vicinity of differentiating primodia. Similar findings were obtained by Singh and Singh (1984) [15] and Singh and Choudhary (1988) [16] in cucumber.

3.2.3 Days to appearance of 50 percent female flower

The response of different treatments on days to appearance of 50 per cent female flowering differed significantly among all the treatments, treatment T_3 (ethrel @150 ppm) was found to be most effective in reducing number of days (36.32) for appearance of 50 per cent female flower. Early flowering of ethrel treated plants due to induction of tendency of femaleness in the plant and increased concentrations of auxins might have resulted in the early induction of female flowers. Similar findings were obtained by Verma *et al.* (1986) [21], Patil *et al.* (1983) [11], Singh and Singh (1984) [15], Singh and Choudhary (1988) [16] in cucumber.

3.2.4 Number of male and female flower

The response of different treatments on number of male and female flowers per plant differed significantly. As regards the number of male flowers, it was observed that the minimum (74.13) number of male flowers per vine was observed in T_3 (ethrel @ 150 ppm), which was at par with T_2 (80.80). The maximum (101.53) number of male flowers per vine was noted in T_7 (control), whereas maximum (29.58) number of female flowers per vine was observed in T_3 (ethrel @ 150 ppm), which was at par with T_2 (28.31). The minimum (14.45) number of female flowers per vine was noted in T_7 (control). Is may be due to ethrel may cause reduction in GA3 level in plant to bring favourable changes to femaleness in cucumber plant (Kshirsagar *et al.* 1995) [7]. Also the increased number of branches has maximized the number of female flowers per vine. Similar results were also observed by Kshirsagar *et al.* (1995) [7] in cucumber.

3.2.5 Sex ratio (M: F)

The lowest sex ratio (2.50) was observed in vine sprayed with 150 ppm ethrel (T_3) which was at par with T_2 (2.85), while the highest sex ratio (7.1) was observed in T_7 (control). This may be due to the reason that the sexual differentiation is controlled by endogenous concentrations of auxins which are altered by the ethrel, which developed flowering primordia and during flowering act as anti-gibberellin substance. This anti-gibberellin effect suppressed staminate flowers and promotes more number of pistillate flowers and thus registers lower sex ratio. Similar results were also recorded by Ghani *et al.* (2013) in bitter gourd.

Table 1: Influence of different concentration of ethrel and NAA on yield of Cucumber

Treatments	Days to first harvesting	Duration of fruiting (Days)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Number of fruit per vine	Fruit yield (kg plot^{-1})	Fruit yield (t ha^{-1})
T_1: Ethrel @ 50 ppm	49.12	48.30	13.73	3.91	161.34	10.39	19.66	30.33
T_2: Ethrel @ 100 ppm	47.77	49.07	13.60	4.08	162.01	11.24	21.40	33.03
T_3: Ethrel @ 150 ppm	45.76	49.97	13.02	4.59	164.22	11.97	23.08	35.62
T_4: NAA @ 50 ppm	53.06	44.27	14.70	3.48	160.14	9.84	18.44	28.46
T_5: NAA @ 100 ppm	52.08	46.43	14.60	3.54	159.03	10.22	19.03	29.37
T_6: NAA @ 150 ppm	49.03	47.63	14.17	3.61	157.41	10.29	18.96	29.26
T_7: Control (No Spray)	54.87	42.20	12.78	3.45	152.72	8.98	15.99	24.68
S.Em. ±	1.47	1.83	0.52	0.16	3.87	0.37	0.89	1.37
C. D. at 5%	4.53	NS	NS	0.48	NS	1.13	2.73	4.22
C. V. %	5.07	6.77	6.51	7.06	4.20	6.12	7.88	7.88

Table 2: Influence of different concentration of ethrel and NAA on flowering of Cucumber

Treatments	Node of first male flower appear	Node of first female flower appear	Days taken to 50 percent male flowering	Days taken to 50 percent female flowering	Number of male flowers per vine	Number of female flowers per vine	Sex ratio (M:F)
T_1: Ethrel @ 50 ppm	2.57	4.67	37.84	41.22	85.00	25.78	3.30
T_2: Ethrel @ 100 ppm	2.73	4.40	36.07	38.89	80.80	28.31	2.85
T_3: Ethrel @ 150 ppm	3.27	3.67	33.24	36.32	74.13	29.58	2.50
T_4: NAA @ 50 ppm	2.93	5.20	41.14	44.13	94.14	20.51	4.60
T_5: NAA @ 100 ppm	2.53	4.80	39.14	42.22	89.67	21.71	4.14
T_6: NAA @ 150 ppm	2.27	4.73	38.10	41.10	87.27	24.25	3.60
T_7: Control (No Spray)	2.07	5.80	44.90	47.85	101.53	14.45	7.10
S.Em. ±	0.10	0.16	1.53	1.48	2.84	0.95	0.24
C. D. at 5%	0.31	0.51	4.73	4.55	8.74	2.93	0.72
C. V. %	6.71	6.01	6.88	6.14	5.61	7.01	1.015

4. Conclusions

Cucumber is monoceous plant and its flowering behavior was modified by applying different PGRs which directly influence the yield of plant. The results obtained from the study "Influence of different concentration of ethrel and NAA on yield and flowering parameters of Cucumber cv. Pusa Sanyog" indicated that application of Ethrel @ 150 ppm at two and four leaf stage was most effective in reveling for inducing early and more number of female flowers, lowering the male: female sex ratio, producing maximum fruit yield.

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