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INFLUENCE OF PLANT GROWTH REGULATORS AND STAGE OF APPLICATION ON SEX EXPRESSION OF BITTER GOURD (*MOMORDICA CHARANTIA* L.) *CV.* VK-1-PRIYA

Aishwarya K.[1], Syam Sundar Reddy P.[1*], Sadarunnisa Syed[1], Ramaiah M.[2] and Srinivasa Rao G.[3]

[1*]Department of Vegetable Science, College of Horticulture, Anantharajupeta-516105 (Andhra Pradesh) India
[2]Department of Entomology, College of Horticulture, Anantharajupeta-516105 (Andhra Pradesh) India
[3]Department of Soil Science, College of Horticulture, Anantharajupeta-516105 (Andhra Pradesh) India

Abstract

The results of the experiment revealed that the application of ethrel 200 ppm resulted in earliness to first pistillate flower appearance (34.30), delayed male flower appearance (32.78), highest female flowers per vine (41.40), minimum number of male flowers (253.46). Narrow sex ratio and female flower at lower node (6.12 and 11.99, respectively) were recorded with ethrel 200 ppm (8.75 and 15.30 respectively). Application of growth regulators at 2-4 leaf stage (S_1) resulted in earliest first pistillate flower appearance with least number of days (35.42) followed by the application of growth regulators at four-leaf and flower initiation stage (S_2). Lowest number of male flowers per vine (268.98) and lowest sex ratio (7.05) was recorded with two to four-leaf stage (S_1) application. Highest number of female flowers per vine (38.23) was recorded with sprays at two to four-leaf stage (S_1). Spraying of growth regulator at 2-4 leaf stage might have suppressed the male bud initiation and enhanced female flower bud initiation.

Key words : bitter gourd, plant growth regulator, sex expression.

Introduction

Bitter gourd (*Momordica charantia* L.) is one of the most important cucurbit vegetable belongs to the family cucurbitaceae. Green fruits of bitter gourd are generally used as vegetable. The fruits are good source of carbohydrates, proteins, vitamins and minerals and have highest nutritive value among cucurbits. It has immense medicinal properties due to the presence of beneficial phytochemicals which are known to have antibiotic, anti mutagenic, antioxidant, antiviral, antidiabetic and immune enhancing properties.

Sex expression is a complex characteristic in plants and is influenced by genetic, environmental and hormonal factors. The principle of sex modification in cucurbits lies in altering the sequence of flowering and sex ratio. Besides the environmental factors, endogenous levels of auxins, gibberellins, ethylene and ascorbic acid determine the sex ratio and sequence of flowering. Hence modification of sex in desired direction has to be manipulated by exogenous application of plant growth regulators once, twice or even thrice at different intervals (Hossain *et al.,* 2006). The application of plants growth regulators has been found to be effective in initiating higher percentage of female flowers and there by modifying the sex ratio and ultimately resulting in more fruiting in cucurbits. A relationship between growth substances and sex expression probably exists in these plants. During the flowering period, a high auxin level in the vicinity of differentiating primordium and staminate organs by a low level favours the formation of pistillate organs.

Use of plant growth regulators (PGRs) may be a useful alternative to induce more number of female flowers. It was reported that exogenous application of NAA, Ethrel, GA_3, growth retardant (MH) may shift the sex expression in cucurbits towards femaleness by increasing the number of pistillate flowers, number of fruits/plant and individual fruit weight as well as yield. Bitter gourd exhibits a wide spectrum of sex form and diversity of sex expression leading to suppression of male flowers with increase in the female flowers resulting in

***Author for correspondence :** E-mail: syamhort@yahoo.com

more fruiting. Ethrel induces a profound effect on the early appearance of pistillate flowers at lowest node and produces maximum number of fruits and fruit weight in bitter gourd. The stages of growth regulator spray also play very important role in induction of flowering at lower node and minimum number of days with narrow sex ratio, which decides ultimately the seed yield. Very little information is available on the influence of stages of growth regulators spray and kind of growth regulator on sex expression. Hence, the present investigation is initiated to find out suitable growth regulator and stages of spray on desired sex expression of bitter gourd.

Material and Methods

The present investigation was carried out at Vegetables block, College of Horticulture, Anantharajupeta, Dr. Y.S.R. Horticultural University, Andhra Pradesh. during *kharif* 2018 under irrigated conditions. The experiment was conducted on red loamy soil with moderate fertility and pH 7.76. Bitter gourd *cv.*VK-1-Priya (KAU) was used in the present experiment. The experiment consisted of 27 treatment combinations, involving nine PGRs treatments with two concentrations each of NAA (50 and 100 ppm), GA_3 (15 and 25 ppm), MH (50 and 100 ppm), ethrel (100 and 200 ppm), control (water spray) and three stages of application *viz.*, S_1-2-4 leaf stage, S_2-2-4 leaf and flower initiation stage and S_3-2-4 leaf, flower and fruit initiation stage. The experiment was laid out in factorial randomized block design with three replications. FYM @ 25 tons and recommended dose of fertilizers (100:100:60 kg NPK/ha) were incorporated into soil for the experiment. 50 percent of nitrogen was applied as a basal dose and remaining 50 percent at 50 days after sowing as top-dress. The entire dose of phosphorous and potassium was applied as a basal dose. For proper growth and development of the plants the vines were supported with bamboo sticks initially. Later the vines were trained over the cement pole trellis. All the recommended packages of practices were adopted to raise the crop. The crop was sprayed with different growth regulators during evening hours as per the treatment combinations. Five plants in each treatment and in each replication were randomly selected for recording the biometric observations on sex expression and its related parameters.

Results and discussion

The data on various flowering parameters indicated in table 1 and 2 were showed significant differences among PGRs, stage of application and their interactions.

Among the growth regulators, ethrel 200 ppm (T_8) followed by ethrel 100 ppm (T_7) took more number of days to first male flower appearance (30.70 and 29.67). However control took less number of days to first male flower (26.69) appearance. Among the stages of application highest number of days to first male flower appearance (30.56 and 29.17) were recorded in S_1 (sprayed at 2-4 leaf stage) followed by S_2 (sprayed at 2-4 leaf and flower initiation) respectively. Among the interactions ethrel 200 ppm at 2-4 leaf stage (T_8S_1) significantly took more number of days to first male flower appearance (34.50) followed by ethrel 200 ppm at 2-4 leaf and flower initiation stage (T_8S_2–33.13) and lowest number of days to first male flower appearance (27.00) were recorded with control at 2-4 leaf and flower stage (T_9S_2).

First male flower appearance node was highest (12.91) with GA_3 25 ppm (T_4) followed by ethrel 200 ppm (T_8-11.78). However in control, lowest node number for first male flower appearance was recorded (9.24). Among the stages of application, significantly highest node number for first male flower (10.96) was recorded with S_1 (2-4 leaf stage) followed by S_2-2-4 leaf and flower initiation stage (10.71). Among the interactions, GA_3 25 ppm at 2-4 leaf stage (T_4S_1) recorded significantly maximum node number to first male flower appearance (13.30) followed by Ethrel 200 ppm at 2-4 leaf stage (T_8S_1-12.93) and minimum node number to first male flower appearance (8.63) was recorded in control at 2-4 leaf stage, flower initiation and fruit initiation stage (T_9S_3).

Ethrel 200 ppm (T_8) followed by ethrel 100 ppm (T_7) took least number of days for first female flower appearance (34.30 and 35.69) respectively, while control took highest number of days to first female flower appearance (39.69). Among the stages of application the lowest number of days to first female flower was recorded in S_1- sprayed at 2-4 leaf stage followed by S_2 sprayed at 2-4 leaf and flower initiation stage (35.42 and 36.85). Among the interactions ethrel 200 ppm at 2-4 leaf stage (T_8S_1-32.90) recorded significantly lowest number of days to first female flower followed by GA_3 25 ppm at 2-4 leaf stage (T_4S_1–32.97) and control at 2-4 leaf and flower stage (T_9S_2) took maximum number of days to first female flower appearance (40.03).

Among the growth regulators, significantly lowest node number for first female flower (11.99) appearance was recorded in treatment ethrel 200 ppm (T_8) followed by T_7-ethrel 100 ppm (12.01). Control (T_9) took more number of nodes for first female flower appearance (15.30). Among the stages of application, significantly lowest node number for first female flower appearance (12.45) was recorded in S_1 (sprayed at 2-4 leaf) stage

Table 1: Effect of plant growth regulators and stage of application on number of days and node number to male and female flower appearance in bitter gourd *cv.* VK-1 Priya.

Plant growth regulators (T)	Days to first male flower appearance				Node number to first male flower appearance				Days to first female flower appearance				Node number to first female flower appearance			
	Stage of application (S)				Stage of application (S)				Stage of application (S)				Stage of application (S)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
T_1 (NAA 50 ppm)	28.40	29.73	27.01	28.38	9.63	12.60	10.90	11.04	36.70	39.43	38.10	38.08	12.17	15.17	12.23	13.19
T_2 (NAA 100 ppm)	29.57	28.20	28.03	28.60	11.03	11.17	9.30	10.50	37.73	37.90	39.27	38.30	11.43	12.73	12.37	12.18
T_3 (GA_3 15 ppm)	32.00	29.30	27.20	29.50	10.13	9.53	9.73	9.50	33.70	36.13	37.50	35.78	13.30	11.87	13.47	12.88
T_4 (GA_3 25 ppm)	32.70	30.53	28.67	30.63	13.30	12.50	12.80	12.91	32.97	36.23	38.40	35.87	14.50	14.20	15.23	14.64
T_5 (MH 50 ppm)	29.67	27.93	25.50	27.70	10.80	10.03	10.40	10.41	35.50	37.93	39.67	37.70	11.47	13.07	12.07	12.20
T_6 (MH 100 ppm)	28.83	26.07	26.47	27.12	9.93	10.67	9.47	10.02	35.47	35.07	37.83	36.12	14.73	12.57	14.60	13.97
T_7 (Ethrel 100 ppm)	32.77	30.63	29.67	31.02	12.50	10.80	11.14	11.48	34.37	35.00	37.70	35.69	11.90	12.50	11.63	12.01
T_8 (Ethrel 200 ppm)	34.50	33.13	30.70	32.78	12.93	10.67	11.87	11.78	36.07	33.93	32.90	34.30	11.10	12.50	12.37	11.99
T_9 (Control)	26.57	27.00	26.47	26.69	8.87	9.30	8.63	9.24	39.47	40.03	39.57	39.69	14.80	15.60	15.70	15.30
Mean	30.56	29.17	27.75		10.96	10.71	10.63		35.42	36.85	38.23		12.45	12.88	12.93	
	T	S	T×S		T	S	T×S		T	S	T×S		T	S	T×S	
SEm±	0.42	0.24	0.72		0.12	0.07	0.21		0.51	0.30	0.89		0.19	0.11	0.34	
CD at 5%	1.19	0.69	2.06		0.35	0.20	0.61		1.46	0.85	2.54		0.55	0.32	0.96	

S_1: 2-4 leaf stage; S_2: S_1+flower initiation stage; S_3: S_1+S_2+fruit initiation stage.

Table2: Effect of plant growth regulators and stage of application on number of male and female flowers and sex ratio in bitter gourd *cv.*VK-1 Priya.

Plant growth regulators (T)	Number of male flowers				Number of female flowers				Sex ratio			
	Stage of application (S)				Stage of application (S)				Stage of application (S)			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
T_1 (NAA 50 ppm)	271.37	273.00	278.67	274.35	33.57	38.27	34.27	35.37	8.08	7.13	8.13	7.76
T_2 (NAA 100 ppm)	279.20	285.13	277.90	280.74	38.13	36.47	35.83	36.81	7.32	7.82	7.76	7.63
T_3 (GA_3 15 ppm)	279.00	281.00	280.00	280.00	39.33	37.90	36.80	38.01	7.09	7.41	7.61	7.37
T_4 (GA_3 25 ppm)	275.00	284.00	284.90	281.99	40.90	37.47	36.50	38.29	6.72	7.58	7.86	7.36
T_5 (MH 50 ppm)	264.00	272.00	270.00	268.67	38.77	37.80	36.90	37.82	6.81	7.2	7.32	7.1
T_6 (MH 100 ppm)	256.60	260.50	258.83	258.64	37.87	41.27	37.07	38.73	6.78	6.31	6.98	6.68
T_7 (Ethrel 100 ppm)	262.50	264.97	263.00	253.81	41.30	39.73	36.87	39.30	6.36	6.67	7.13	6.46
T_8 (Ethrel 200 ppm)	251.90	253.07	255.40	253.46	42.60	40.70	40.90	41.40	5.91	6.22	6.24	6.12
T_9 (Control)	280.27	283.47	286.97	283.21	33.47	31.20	32.43	32.37	8.4	9.09	8.79	8.75
Mean	268.98	273.02		272.85	38.23	38.08	36.40		7.04	7.17	7.5	
	T	S	T×S		T	S	T×S		T	S	T×S	
SEm±	1.05	0.61	1.83		1.01	0.59	1.76		0.10	0.06	0.17	
CD at 5%	2.89	1.67	5.00		1.50	0.87	2.60		0.27	0.16	0.48	

S_1: 2-4 leaf stage; S_2: S_1+flower initiation stage; S_3: S_1+S_2+fruit initiation stage.

followed by S_2- sprayed at 2-4 leaf and flower initiation stage (12.88). Among the interactions, ethrel 200 ppm at 2-4 leaf stage (T_8S_1) recorded significantly lowest node number of first female flower appearance (11.10) followed by NAA 100 ppm at 2-4 leaf stage (T_2S_1- 11.43). Control treatment at 2-4 leaf stage (T_9S_1) took more number of nodes to first female flower appearance (14.80). These results are in conformity with the findings of Majid *et al*., (2018) in bottle gourd, Arora and Pratap (1988) in pumpkin, Dubey (1983) in sponge gourd and Arora *et al*., (1982) in bottle gourd.

Significantly lowest number of male flowers were recorded (253.46) with ethrel 200 ppm (T_8) followed by ethrel 100 ppm (T_7-253.81) over control (T_9-283.21). Among the stages of application significantly lowest number of male flowers (268.98) was recorded in S_1-

sprayed at 2-4 leaf stage followed by in S_2- sprayed at 2-4 leaf and flower initiation stage (273.02). Among the interactions, ethrel 200 ppm at 2-4 leaf stage (T_8S_1-251.90) significantly recorded the lowest number of male flowers followed by ethrel 200 ppm at 2-4 leaf, flower initiation stage (T_8S_2-253.07) and highest number of male flowers was recorded in control at 2-4 leaf, flower and fruit initiation stage (T_9S_3-284.97). These results are in conformity with the findings of Sarkar *et al*., (2019) in cucumber, Majid *et al*., (2018) in bottle gourd, Verma *et al*., (1984) in bitter gourd and Dubey *et al*., (1983) in sponge gourd.

Significantly the maximum number of female flowers were recorded (41.4) in ethrel 200 ppm (T_8) followed by ethrel 100 ppm (T_7-39.30) over control (T_9-32.37). Among the stages of application maximum number of female flowers (38.23) was recorded in S_1- sprayed at 2-4 leaf stage followed by S_2- sprayed at 2-4 leaf and flower initiation stage (38.08). Among the interactions ethrel 200 ppm at 2-4 leaf stage (T_8S_1-42.60) recorded maximum number of female flowers followed by Ethrel 100 ppm at 2-4 leaf stage (T_7S_1-41.30), MH 100 ppm at 2-4 leaf stage and flower initiation stage (T_6S_2-41.27), GA_3 25 ppm at 2-4 leaf (T_4S_1-40.90), ethrel 200 ppm at 2-4 leaf, flower and fruit initiation stage (T_8S_3-40.90) and ethrel 200 ppm at 2-4 leaf and flower initiation stage (T_8S_2-40.70). However all the above treatments were at par with each other. Lowest number of female flowers (31.2) was recorded in control at 2-4 leaf stage and flower initiation stage (T_9S_2). Suppression of male flowers by ethrel is due to the reduction in endogenous production of gibberellins during the process of differentiation and alteration on the proportion of gibberellins to auxins and cytokinins which gradually induce the suppression of male flower production and induction of more female flowers. These results are in conformity with the findings of Majid *et al*., (2018) in bottle gourd, Kadi *et al*., (2018) in cucumber, Mangave *et al*., (2017) in bitter gourd, Chourasiya *et al*., (2016) in muskmelon, Nagamani *et al*., (2015) in bitter gourd and Hilli *et al*., (2010) in ridge gourd.

Significantly lowest male: female sex ratio was recorded (6.12) in ethrel 200 ppm (T_8) followed by ethrel 100ppm (T_7-6.46). Maximum sex ratio was recorded in control (T_9-8.75). Among the stages of application, significantly lowest male: female sex ratio (7.04) was recorded in S_1-sprayed at 2-4 leaf stage followed by S_2-sprayed at 2-4 leaf stage and flower initiation stage (7.17). Among the interactions ethrel 200 ppm at 2-4 leaf stage (T_8S_1) recorded significantly lowest male: female sex ratio (5.91) followed by ethrel 100 ppm at 2-4 leaf stage and flower initiation stage (T_8S_2-6.22) and the maximum sex ratio (8.40) was recorded in control at 2-4 leaf stage and flower initiation stage (T_9S_2).

Exogenous application of ethrel altered the sex ratio and sequence of flowering in cucurbits by increasing the female flower production and suppressing the male flower production resulting in lower sex ratio. This might be due to the retardation of starch digestion, transpiration as well as respiration in plant tissues after ethrel treatment. These results are in conformity with the findings of Kadi *et al*., (2018) in cucumber Shafeek *et al*., (2016), Chourasiya *et al*., (2016) in musk melon and Hilli *et al*., (2008) in ridge gourd.

Conclusion

This experiment has brought out some vital information that the ethrel 200 ppm was found to be the most suitable PGR for increasing various flowering parameters *viz.,* delayed days to first male flower, lowest node number to female flower appearance, lowest number of days taken to first female flower, lower male: female sex ratio and highest number of pistillate flowers. Among the stage of application, PGRs sprayed at 2-4 leaf stage was found to be superior in enhancing high female: male sex ratio.

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