International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 2688-2692

Received: 10-05-2019
Accepted: 12-06-2019

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Effect of plant growth regulators and stage of application on morphological and yield parameters of bitter gourd cv. VK-1 Priya

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Abstract
A field experiment was conducted at Vegetables block, College of Horticulture, Anantharajupeta, Dr. Y. S. R. Horticultural University, Andhra Pradesh. during *kharif* 2018 to study the effect of plant growth regulators and stage of application on morphological, yield and yield components in bitter gourd cv. VK-1 Priya. The experiment consists of 9 PGR treatments with two concentrations each of NAA (50, 100 ppm), GA_3 (15, 25 ppm), MH (50, 100 ppm), Ethrel (100, 200 ppm) and control (water spray) and three stages of PGRs application *viz*., S_1 (2-4 leaf stage), S_2 (2-4 leaf stage and flower initiation stage) and S_3 (2-4 leaf stage, flower initiation and fruit stage).The results indicated significant differences between the growth regulators and stage of application on all growth and yield parameters at all the stages. Among the treatments application of GA_3 25 ppm significantly recorded maximum vine length (31.56 cm, 188.33 cm and 335.56 cm at 20, 40 DAS and at final harvest respectively), highest male flower node number (12.91) and maximum number of leaves (26.47, 101.07 and 241.03 at 20, 40 DAS and at final harvest respectively) and maximum leaf area (116.02 cm^2). MH 100 ppm significantly recorded maximum number of branches per vine (13.57), while ethrel 200 ppm recorded lowest number of days to 50% flowering (30.30), maximum fruit diameter (8.39 cm), maximum fruit yield per plant (3.30 kg) and maximum fruit yield per hectare (17.511 t). Ethrel 200 ppm took least number of days to first fruit harvest (54.19) and extended the days to last fruit harvest (123.21). NAA 100 ppm significantly recorded maximum fruit set percentage (87.60). Among the stage of application, PGRs spray at 2-4 leaf stage was found to be superior in enhancing both morphological and yield parameters.

Keywords: Bitter gourd, growth regulators, stage of application, NAA, GA_3, MH, ethrel, yield

Introduction
Bitter gourd (*Momordica charantia* L.) is one of the most important cucurbitaceous vegetable widely cultivated in India. In India, it is cultivated in an area of 93,000 ha with a production of 10.63 lakh MT and the productivity is 6.23 t/ha (Anon, 2017). 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 (Grover and Yadav, 2004) [7]. Bitter gourd is annual monoecious vine. The crop induces greater number of male flowers than female flowers which is not economical and significantly reduces crop yield. Globally PGRs have been used widely in crop production as it has significant positive effect on crop production. PGRs are being used to enhance the yield (Nickell, 1982) [18]. In addition, they can enhance the fruit set and also seed yield. The growth regulators include both growth promoters and retardants which have been shown to modify the canopy structure and other yield attributes. The effect of growth regulators varies with plant species, variety, concentration of growth regulator, method of application, frequency of application and stage of application.

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. Since, very little information is available on the effect of growth regulators and stage of application on morphological and yield parameters in vegetables especially in bitter gourd, the present investigation was aimed to find out suitable growth

regulators for increasing the fruit yield potential and also quality in bitter gourd with the objective to find out the effect of plant growth regulators on growth and yield in bitter gourd.

Material and Methods

A field experiment was conducted at Vegetables block, College of Horticulture, Anantharajupeta, Dr. Y. S. R. Horticultural University, Andhra Pradesh during *kharif* 2018. The experiment consisted 9 PGR treatments with two concentrations each of NAA (50, 100 ppm), GA_3 (15, 25 ppm), MH (50, 100 ppm), Ethrel (100, 200 ppm), control (water spray) and three stages of PGRs application *viz*., S_1 (2-4 leaf stage), S_2 (2-4 leaf stage and flower initiation stage) and S_3 (2-4 leaf stage, flower initiation and fruit stage). The experiment was laid out in factorial randomized block design with three replications. Five randomly selected plants in each treatment in each replication were tagged for recording of observations for all the characters.

Total number of fruits was estimated by counting the individual fruit from the plant and the mean value at three plants selected at random in each treatment was expressed as number per plant. The total fruit yield was calculated both as t/ha and kg/vine. Fruit yield was calculated by multiplying total plant population per hectare by total yield per vine of three randomly labeled plants.

Results and Discussion

The data on various morphological parameters indicated in Table 1, 2 and 3 showed significant differences among PGRs, stage of application and their interactions except days from fruit set to edible maturity.

The results of the experiment revealed that application of GA_3 25 ppm (T_4) significantly recorded maximum vine length (31.56 cm, 188.33 cm and 335.56 cm at 20, 40 DAS and at final harvest respectively) and highest male flower node number (12.91) at 2-4 leaf stage (S_1); maximum number of leaves (26.47, 101.07 and 241.03 at 20, 40 DAS and at final harvest respectively) and maximum leaf area (116.02 cm^2) at S_2 stage (2-4 leaf and flower initiation stage) respectively. The promotion of growth in terms of increase in the vine length, leaf area and leaf number might be due to increasing plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell, resulting in the entry of water into the cell causing elongation. These osmotic driven responses under the influence of gibberellins might have attributed to increase in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, thus resulting in increased cell elongation and rapid cell division in the growing portion. These results are in conformity with the findings of Majid *et al.* (2018) [15] in bottle gourd, Kadi *et al.* (2018) [11], Hirpara *et al.* (2014) [9], Geeta *et al.* (2010) [5], Chaudhary *et al.* (2016) [4], Arora *et al.* (1982) [2] and Mangal *et al.* (1981) [13] and Sarkar *et al.* (2019) [19] in cucumber.

Application of MH 100 ppm at S_1 (2-4 leaf stage) significantly recorded maximum number of branches per vine (13.57) which was on par with MH 50 ppm (T_5 - 13.24 per vine) The increase in number of branches per vine might be due to the ability of MH to retard vine length, promote lateral branching since MH acts as anti-gibberellins. These results are in conformity with the findings of Majid *et al.* (2018) [15] in bottle gourd, Chaurasia *et al.* (2016) in musk melon and Kaur *et al.* (2016) [12] in cucumber. The stimulative effect of MH at 100 ppm on number of branches was also noticed in cucumber at 4 leaf stage by Tantasawat *et al.* (2015) [23] and Sinojiya *et al.* (2015) [21] in water melon.

Ethrel 200 ppm (T_8) followed by ethrel 100 ppm (T_7) recorded lowest number of days to 50% flowering (32.91 and 33.69). However control (T_9) took highest number of days to 50% flowering (37.69). The variation in the days taken to 50% flowering might be due to the effect of PGR's on different treatments. These results are in conformity with the findings of Hilli *et al.* (2010) [8] and Thappa *et al.* (2011) [24] in ridge gourd.

The data on various yield and yield attributing parameters indicated in Table 4 and 5 showed significant differences among PGRs, stage of application and their interactions. Among the growth regulators, ethrel 200 ppm sprayed at 2-4 leaf and flower initiation stage (S_2) recorded significantly highest fruit diameter (8.39 cm) followed by ethrel 100 ppm (T_7-8.34cm). The lowest fruit diameter was recorded in control (6.62cm). Ethrel increased endogenous levels of auxins in turn increasing the fruit diameter. The elongation of cells of the fruit by auxins is diametric leading to the simultaneous increase in fruit diameter. These results are in conformity with the findings of Majid *et al.* (2018) [15] in bottle gourd, Kadi *et al.* (2018) [11] in cucumber, Soni *et al.* (2016) [22] in bottle gourd, Jyoti *et al.* (2016) [10] in ridge gourd, Sinojiya *et al.* (2015) [21] in watermelon, Nagamani *et al.* (2015) [16] in bitter gourd and Ghani *et al.* (2013 in bitter gourd [6].

Significantly lowest number of days to first fruit harvest (54.19) was recorded in ethrel 200 ppm sprayed at 2-4 leaf stage (S_1) followed by GA_3 25ppm (T_4-55.37). Since ethrel has a role in stimulating early female flowering therefore ethrel application in the present study caused early harvesting. These results are in conformity with the findings of Kadi *et al.* (2018) [11] in cucumber, Soni *et al.* (2016) [22] in bottle gourd, Chourasiya *et al.* (2016) in muskmelon and Ghani *et al.* (2013) [6] in bitter gourd.

Ethrel 200 ppm sprayed at S_3 stage (2-4 leaf, flower initiation and fruit initiation) followed by ethrel 100 ppm (T_7) significantly extended the harvesting period and took more number of days to last fruit harvest (123.21 and 121.31 respectively) over control. Ethrel caused early female flowering and it resulted in increase in crop duration. Due to early female flowering in ethrel treatments, it took significantly less number of days to 50% harvesting over control from date of sowing. The harvesting period is also extended if first harvesting is advanced which resulted in enhanced total crop duration.

Significantly highest fruit set percentage (87.60) was recorded in treatment NAA 100 ppm when sprayed at S_1 (2-4 leaf stage) followed by NAA 50 ppm (80.90). Minimum fruit set percentage was recorded in control (61.00). Exogenous application of NAA improved the number of fruits to the number of female flowers produced per plant which resulted in higher fruit set percentage. These results are in conformity with the findings of Nagamani *et al.* (2015) [16] in bitter gourd and Ghani *et al.*, (2013) [6] in bitter gourd.

Significantly highest fruit yield per plant was recorded with the treatment ethrel 200 ppm (T_8 -3.30 kg) at 2-4 leaf stage followed by ethrel 100 ppm (T_7 - 2.97 kg), GA_3 25 ppm (T_4-2.33 kg) and GA_3 15 ppm (T_3-2.09 kg). Among these T_7 and T_4 were at par with T_8. Lowest fruit yield per plant was recorded in control (T_9 -1.51kg). Significant increase in fruit yield per plant by ethrel application could be due to increase in female flowers per plant and metabolic activity of plants. It appears to be a consequence of more number of female

flowers and fruits set per vine. These results are in conformity with the findings of Majid *et al.* (2018) [15] in bottle gourd, Kadi *et al.* (2018) [11] in cucumber, Nayak *et al.* (2017) [17] in cucumber, Soni *et al.* (2016) [22] in bottle gourd, Kaur *et al.*, (2016) [12] in cucumber, Sinojiya *et al.* (2015) [21] in watermelon, Nagamani *et al.* (2015) [16] in bitter gourd, Hirpara *et al.* (2014) [9] in bitter gourd and Sure *et al.* (2013) [20] in pumpkin.

Significantly highest fruit yield per hectare was recorded with the treatment ethrel 200 ppm (T_8 - 17.51 t) sprayed at 2-4 leaf stage followed by ethrel 100 ppm (T_7 - 16.60 t) and GA_3 25 ppm (T_4-16.02 t). Minimum fruit yield per hectare was recorded in control (T_9 - 12.81 t). An increase in fruit yield in treated plants may be attributed to the reason that plants remained physiologically more active to build up sufficient food stock for the developing flowers and fruits ultimately leading higher yield. It appears to be a consequence of more number of female flowers, maximum fruits set per vine and average fruit weight. These results are in conformity with the findings of Majid *et al.* (2018) [15] in bottle gourd, Kadi *et al.* (2018) [11] in cucumber, Mangave *et al.* (2017) in bitter gourd, Soni *et al.* (2016) [22] in bottle gourd at, Kaur *et al.*, (2016) [12] in cucumber, Chourasiya *et al.* (2016) in muskmelon, Sinojiya *et al.* (2015) [21] in watermelon and Hilli *et al.*, (2010) [8] in bitter gourd.

Conclusion

The experiment has conclusively brought out some vital information that the ethrel 200 ppm was found to be the most suitable plant growth regulator for increasing various growth, yield and yield attributing parameters *viz.*, fruit diameter, early and extended harvest, total fruit yield, early maturity, delayed days to first male flower, lowest node number for female flower appearance, days taken to first female flower and highest fruit yield.

Among the stage of application, PGRs spray at 2-4 leaf stage was found to be superior in enhancing the total yield due to high fruit set percentage. Fruit parameters *viz*., fruit diameter and weight was increased due to PGRs spray both at 2-4 leaf and flower initiation stage.

Table 1: Effect of plant growth regulators and stage of application on vine length (cm) in bitter gourd cv. VK-1 Priya

Vine length (cm)												
Plant growth regulators (T)	**20 DAS**				**40 DAS**				**At final harvest**			
	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)	33.00	27.00	25.00	28.33	181.67	165.00	153.33	171.11	348.00	290.00	266.67	302.22
T_2 (NAA 100 ppm)	31.67	30.00	31.00	30.89	190.00	175.00	186.67	183.89	323.33	310.00	333.33	331.11
T_3 (GA_3 15 ppm)	30.33	29.33	31.33	31.22	188.33	183.33	186.67	186.11	336.67	326.67	333.33	332.22
T_4 (GA_3 25 ppm)	33.00	32.67	31.67	31.56	195.00	193.33	190.00	188.33	350.00	346.67	336.67	335.56
T_5 (MH 50 ppm)	24.33	25.00	26.00	25.11	151.67	155.00	160.00	155.56	263.33	270.00	280.00	271.11
T_6 (MH 100 ppm)	25.33	23.33	25.33	24.67	156.67	146.67	160.00	154.44	273.33	253.33	280.00	268.89
T_7 (Ethrel 100 ppm)	31.67	26.00	24.33	27.33	188.33	160.00	151.67	166.67	336.67	280.00	263.33	293.33
T_8 (Ethrel 200 ppm)	31.67	24.33	27.33	27.78	188.33	151.67	166.67	168.89	336.67	263.33	293.33	297.78
T_9 (Control)	25.00	22.33	25.33	24.22	155.00	141.67	156.67	151.11	270.00	243.33	273.33	262.22
Mean	29.56	26.67	27.48		177.22	163.52	167.96		315.56	287.04	295.56	
	T	S	T×S		T	S	T×S		T	S	T×S	
SEm±	0.48	0.28	0.83		2.50	1.40	4.30		4.75	2.74	8.23	
CD at 5%	1.36	0.79	2.36		7.00	4.04	12.13		13.52	7.81	23.42	

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

Table 2: Effect of plant growth regulators and stage of application on number of leaves per plant at different stages in bitter gourd.

Number of leaves per plant												
Plant growth regulators (T)	**20 DAS**				**40 DAS**				**At Final Harvest**			
	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)	22.43	22.20	21.00	21.88	84.00	87.00	86.33	85.78	209.00	211.00	207.00	209.00
T_2 (NAA 100 ppm)	22.20	23.30	23.90	23.13	91.00	90.50	91.67	91.06	220.90	219.90	222.90	221.23
T_3 (GA_3 15 ppm)	23.60	25.40	25.20	24.73	100.20	101.00	99.20	100.13	238.33	241.30	237.40	239.35
T_4 (GA_3 25 ppm)	25.40	28.90	25.10	26.47	99.40	102.90	100.90	101.07	240.70	243.70	239.70	241.03
T_5 (MH 50 ppm)	21.10	23.00	24.10	22.73	94.50	96.50	95.50	95.50	230.00	232.00	228.00	230.00
T_6 (MH 100 ppm)	22.00	24.37	24.00	23.46	97.20	95.20	96.20	96.20	231.40	229.40	233.40	231.40
T_7 (Ethrel 100 ppm)	24.80	23.10	23.10	23.67	91.10	93.00	92.10	92.07	223.10	225.10	221.10	223.10
T_8 (Ethrel 200 ppm)	23.60	24.20	23.80	23.87	91.40	92.40	90.00	91.27	220.13	223.80	221.83	221.92
T_9 (Control)	23.10	21.37	18.87	21.11	80.00	81.00	79.00	80.00	197.00	201.00	199.00	199.00
Mean	23.14	23.98	23.23		92.18	93.19	92.32		223.40	224.81	223.80	
	T	S	T×S		T	S	T×S		T	S	T×S	
SEm±	0.22	0.13	0.38		0.19	0.11	0.33		0.17	0.10	0.29	
CD at 5%	0.63	0.36	1.09		0.55	0.32	0.95		0.47	0.27	0.82	

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

Table 3: Effect of plant growth regulators and stage of application on various morphological parameters in bitter gourd cv. VK-1 Priya.

Plant growth regulators (T)	Leaf area (cm^2)				Number of branches/plant				Days to 50% flowering				Fruit set percentage			
	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)	95.93	111.35	103.10	103.46	12.87	13.00	11.77	12.54	34.70	37.43	36.10	36.08	79.60	81.70	81.20	80.90
T_2 (NAA 100 ppm)	106.00	96.08	98.77	100.28	13.30	12.50	12.10	12.63	35.73	35.90	37.27	36.30	92.40	88.30	82.10	87.60
T_3 (GA_3 15 ppm)	112.27	108.30	112.13	110.90	12.20	11.43	12.00	11.88	31.93	34.13	35.50	33.78	65.80	66.80	67.40	66.60
T_4 (GA_3 25 ppm)	117.30	118.43	112.33	116.02	11.77	11.67	11.27	11.57	30.97	34.23	36.40	33.87	82.50	77.60	74.30	78.10
T_5 (MH 50 ppm)	91.83	92.00	93.00	92.28	13.57	13.23	12.93	13.24	33.50	35.93	37.67	35.70	69.20	72.20	74.30	71.90
T_6 (MH 100 ppm)	98.91	96.83	96.20	97.31	13.97	13.63	13.23	13.57	33.47	33.07	35.83	34.12	78.20	69.50	72.60	73.40
T_7 (Ethrel 100 ppm)	106.00	108.00	110.00	108.00	13.10	12.70	12.40	12.73	32.37	33.00	35.70	33.69	76.40	77.80	77.20	77.10
T_8 (Ethrel 200 ppm)	97.83	111.00	108.00	105.61	13.83	11.50	12.30	12.59	31.70	34.70	32.10	32.91	78.00	67.30	73.00	72.70
T_9 (Control)	89.20	92.33	88.67	90.07	11.10	8.57	6.43	8.70	37.47	38.03	37.57	37.69	58.30	61.40	63.40	61.00
Mean	101.70	103.82	102.47		12.86	12.03	11.60		33.85	34.85	36.02		75.60	73.60	73.90	
	T	S	T×S		T	S	T×S		T	S	T×S		T	S	T×S	
SEm±	0.93	0.54	1.61		0.17	0.10	0.30		0.42	0.24	0.72		1.13	0.65	1.96	
CD at 5%	2.65	1.53	4.59		0.49	0.28	0.84		1.19	0.69	2.06		3.22	1.86	5.58	

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

Table 4: Effect of plant growth regulators and stage of application on days to first fruit harvest, last fruit harvest and fruit diameter in bitter gourd.

Plant growth regulators (T)	Days to first fruit harvest				Days to last fruit harvest				Fruit diameter (cm)			
	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)	57.98	63.46	61.81	61.08	117.67	116.93	118.87	117.82	7.53	7.57	6.73	7.28
T_2 (NAA 100 ppm)	57.65	59.05	61.15	59.28	116.00	121.47	119.83	119.10	8.03	8.07	7.90	8.00
T_3 (GA_3 15 ppm)	59.65	58.91	60.85	59.80	114.67	116.07	118.17	116.30	8.50	8.07	7.70	8.09
T_4 (GA_3 25 ppm)	55.45	56.85	53.81	55.37	117.47	118.87	115.83	117.39	8.13	8.47	7.77	8.12
T_5 (MH 50 ppm)	60.85	62.38	63.65	62.29	120.20	122.37	117.13	119.90	7.77	7.60	7.87	7.74
T_6 (MH 100 ppm)	66.67	68.85	63.61	66.38	119.00	120.53	122.07	120.53	7.40	7.90	7.40	7.57
T_7 (Ethrel 100 ppm)	53.98	55.51	57.05	55.51	120.87	122.40	123.20	121.31	8.33	8.50	7.87	8.34
T_8 (Ethrel 200 ppm)	54.08	53.31	55.18	54.19	122.10	121.33	123.67	123.21	8.40	8.83	8.27	8.39
T_9 (Control)	66.41	69.75	72.48	69.54	112.43	110.73	113.60	112.26	6.57	6.80	6.50	6.62
Mean	58.19	60.81	61.65		117.82	118.97	120.15		7.86	7.97	7.56	
	T	S	T×S		T	S	T×S		T	S	T×S	
SEm±	0.51	0.29	0.88		0.52	0.30	0.90		0.09	0.05	0.16	
CD at 5%	1.44	0.83	2.50		1.47	0.85	2.55		0.26	0.15	0.46	

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

Table 5: Effect of plant growth regulators and stage of application on fruit yield per plant (kg) and fruit yield per ha (t) in bitter gourd cv. VK-1 Priya

Plant growth regulators (T)	Fruit yield per plant (kg)				Fruit yield per ha (t/ha)			
	Stage of application (S)				Stage of application (S)			
	S_1	**S_2**	**S_3**	**Mean**	**S_1**	**S_2**	**S_3**	**Mean**
T_1 (NAA 50 ppm)	1.89	1.86	1.92	1.89	14.43	14.00	13.80	14.08
T_2 (NAA 100 ppm)	2.03	2.12	1.95	2.03	16.23	15.70	15.90	15.94
T_3 (GA_3 15 ppm)	2.05	2.14	2.07	2.09	16.10	15.80	15.53	15.81
T_4 (GA_3 25 ppm)	2.52	2.38	2.10	2.33	16.40	16.20	15.47	16.02
T_5 (MH 50 ppm)	1.58	1.76	1.58	1.64	13.47	13.17	13.43	13.36
T_6 (MH 100 ppm)	1.69	1.69	1.74	1.71	15.13	15.20	14.93	15.09
T_7 (Ethrel 100 ppm)	2.99	2.96	2.96	2.97	16.40	16.60	16.80	16.60
T_8 (Ethrel 200 ppm)	3.87	3.08	2.95	3.30	17.83	17.50	17.20	17.51
T_9 (Control)	1.71	1.57	1.25	1.51	13.27	12.60	12.57	12.81
Mean	2.36	2.19	2.01		15.25	14.97	14.75	
	T	S	T×S		T	S	T×S	
SEm±	0.04	0.02	0.07		0.10	0.06	0.18	
CD at 5%	0.11	0.06	0.19		0.29	0.17	0.50	

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

References

1. Anonymous. National Horticulture Data Base. National Horticulture Board. Ministry of Agriculture, Government of India, 2017.
2. Arora SK, Pandita ML, Sidhu AS. Effect of various plant growth regulators on vegetable growth, sex expression and fruit yield in summer squash (*Cucurbita pepo* L.). Haryana Agricultural University Journal. 1982; 12(4):598-604.
3. Chaurasiya J, Verma RB, Ahmad M, Adarsh A, Kumar R, Pratap T. Influence of plant growth regulators on

growth, sex expression, yield and quality of Muskmelon (*Cucumis melo* L.). Eco. Env. & Cons. 2016; 22:39-43.
4. Chaudhary DC, Patel NM, Rathva VD, Nurbhanej MH. Effect of growth substances on growth, flowering, yield and quality attributes of watermelon (*Citrullus lanatus thunb mansf*.) cv. Durgapura lal. International journal of Agriculture sciences. 2016; 8(40):1825-1828.
5. Geeta B, Nawalagatti CM, Doddamani MB, Chetti MB. Effect of plant growth regulators on morpho-physiological parameters and yield in bitter gourd. International Journal of Agricultural Sciences. 2010; 6(2):504-507.
6. Ghani MA, Amjad M, Iqbal Q, Nawaz A, Ahmad T, Hafeez O *et al.* Efficacy of Plant Growth Regulators on Sex Expression, Earliness and Yield Components in Bitter Gourd. Pakistan Journal of Biological Sciences. 2013; 11(3):218-224.
7. Grover JK, Yadav SP. Pharmacological action and potential uses of *Momordica charentia* L. Journal of Ethnopharmacol. 2004; 93 (1):123-132.
8. Hilli JS, Vyakarnahal BS, Biradar DP, Hunje R. 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 Science. 2010; 23(2):239-242.
9. Hirpara Anjita J, Vaddoria MA, Jivani LL, Patel JB, Polara AM. Seed yield and quality as influence by plant growth regulators and stages of spray in bitter gourd (*Momordica charantia* L.). AGRES – An International e-Journal. 2014; 3(3): 282-287.
10. Jyoti S, Patel NB, Patel JB. Effect of growth regulators and stages of spray on seed yield and seed quality parameters of ridge gourd [*Luffa acutangula* (Roxb) L.]. Journal of Applied and Natural Science. 2016; 8(3):1551–1555.
11. Kadi AS, Asati KP, Barche S, Tulasigeri RG. Effect of Different Plant Growth Regulators on Growth, Yield and Quality Parameters in Cucumber (*Cucumis sativus* L.) under Polyhouse Condition. International Journal of Current Microbiological Applied Science. 2018; 7(04):3339-3352.
12. Kaur A, Khurana DS, Dhall RK. Sex modification in Cucumber (*Cucumis sativus* L.) under the influence of Ethephon and Maleic hydrazide. International Journal of Advance Research. 2016; 4(11):2199-2205.
13. Mangal JL, Pandita ML, Singh GR. Effect of various chemicals on growth, flowering and yield of bittergourd. Indian Journal of Agriculture Research. 1981; 15(3):185-188.
14. Mangave BD, Dekhane SS, Patel DJ, Dumbre RB. Effect of plant growth regulaters on growth and sex expression of bitter gourd. Adv. Res. J Crop Improv. 2017; 8(2):83-185.
15. Majid AA, Chowdhary BM. Effects of boron and plant growth regulators on bottle gourd (*Lagenaria siceraria* (Molina) Standle.). Journal of Pharmacognosy and Phytochemistry. SP1, 2018, 202-206.
16. Nagamani S, Basu S, Singh SK, Lal S, Behera TK, Chakrabarty SK. Effect of plant growth regulators on sex expression, fruit setting, seed yield and quality in the parental lines for hybrid seed production in bitter gourd (*Momordica charantia*). Indian Journal of Agricultural Sciences. 2015; 85(9):1185–91.
17. Nayak SR, Parmar VK, Patel AN, Jena S, Lathiya JB, Tandel YN. Efficacy of pinching and plant growth regulators in enhancing yield characters of cucumber (*Cucumis sativus* L.) International journal of chemical studies. 2017; 6(1):1804-1807.
18. Nickell LG. Plant Growth Regulators: Agricultural Uses. Springer Verlag, Berlin. Verlag Berlin-Heidelberg-New York, 1982.
19. Sarkar MD, Moniruzzaman M, Alam MDS, Rahman MDJ, Quamruzzaman MD, Rojoni RN *et al.* Growth, sex expression and nutrient composition of cucumber (*Cucumis sativus*) as influenced by maleic hydrazide. Pakistan journal of botany, 2019, 1(9)
20. Sure S, Arooie H, Azizi M. Effect of GA_3 and Ehtephon on sex expression and oil yield in medicinal pumpkin (*Cucurbita peop* var. *styriaca*) Intl. J. Farm. Alli. Sci. 2013; 2(9):196-201.
21. Sinojiya AG, Kacha HL, Jethaloja BP, Jat G. Effect of Plant growth regulators on growth, flowering, yield and quality of watermelon (*Citrullus lanatus* Thunb.) Shine Beauty. Environment & Ecology. 2015; 33(4A):1774-1778.
22. Soni S, Singh KV, Dalai S. Impact of foliar application of plant bio regulators on yield traits and economics of bottle gourd [*Lagenaria siceraria* (Molina) Standl.]. Resources on Environmental Life Science. 2016; 9(4):497-501. ISSN: 0974-4908.
23. Tantasawat PA, Sorntip A, Pornbungkerd P. Effects of Exogenous Application of Plant Growth Regulators on Growth, Yield, and In Vitro Gynogenesis in Cucumber. HORTSCIENCE. 2015; 50(3):374–382.
24. Thappa MS, Kumar S, Rafiq R. Influence of plant growth regulators on morphological, floral and yield traits of cucumber (*Cucumis sativus* L.). Kasets art Journal (National Science). 2011; 45:177-188.