DOI : 10.58993/ijh/2025.82.1.12

Indian J. Hortic. 82(1), March 2025: 69-76

Role of plant growth regulators on seed quality and seed yield of bitter gourd (*Momordica charantia* L.)

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ABSTRACT

The bitter gourd is the most popular vegetable crop in India as it gives higher yield and maximum returns to the farmers. A field trial was carried out to study the quality seed yield at different growth stages in bitter gourd during *Kharif* season of 2020. Three concentrations each of NAA @ 50, 75 and 100 ppm, GA_3 @ 25, 50 and 75 ppm and ethephon @ 150, 200 and 250 ppm along with control (P0) were applied at three different stages *viz.*, S1 (two leaf stage), S2 (two leaf + four leaf stages) and S3 (two leaf + four leaf stages + bud initiation stage). Amongst different plant growth regulators, foliar application of ethephon @ 250 ppm at stage S3 recorded the maximum seed weight/fruit and seed yield. Highest seedling length, seedling dry weight, vigour index 1 and vigour index 2 were obtained when the plants were sprayed with ethephon @ 250 ppm at stage S3 followed by stage S2. Significantly the maximum germination, seed viability were recorded with ethephon @ 250 ppm applied at stage S3 and minimum was recorded under control, *i.e.* water spray at stage S1. Hence, it may be concluded that foliar application of ethephon @ 250 ppm sprayed three times at two leaf, four leaf and bud initiation stage would be beneficial for higher seed yield and better quality of seeds.

Key words: Foliar spray, ethephon, NAA, GA_3, seed yield.

INTRODUCTION

Vegetables are abundant in vitamins, minerals, proteins and carbohydrates and play a significant role in human nutrition. In addition to their nutritional importance, vegetables are gaining more attention for their medicinal and functional effects on human health. Vegetables from the cucurbit family provide a fair source of thiamine and riboflavin. The bitter gourd is the most popular vegetable crop in India as it gives higher yield and maximum returns to the farmers. Bitter gourd (*Momordica charantia* L.) is a tropical and subtropical vegetable of the family Cucurbitaceae. Bitter gourd is one of the significant and common cucurbitaceous vegetable grown in our country. India is regarded as the major centre of bitter gourd diversity and China as the secondary centre (Grubben, 8). Due to its great nutritional content, particularly ascorbic acid, iron, and medicinally significant anti-diabetic property, it is regarded as a prized vegetable (Behera, 4). Due to high keeping quality, it has also export potentiality. Ayurveda has used the fruits, leaves, and even the roots of this vegetable to treat a variety of ailments. It has immense medicinal properties due to the presence of beneficial phytochemicals, which are known to have antibiotic, antimutagenic, antioxidant, antiviral, anti-diabetic and immune enhancing properties. The bitter gourd contains a compound called charantin, which is used to treat diabetes by lowering the blood sugar levels.

Plant growth regulators (PGRs) have a great potential to boost vegetable productivity. To enhance productivity, growth promoters or growth retardants can be judiciously applied to a variety of vegetable crops. Since PGRs have a great capacity to affect plant growth and morphogenesis, it is important to plan properly for their application and actual assessment in terms of the application stages, optimal concentration, species-specificity, season etc. These create a major impediment in exploiting applicability of PGRs. Altering the order of flowering and sex ratio is the basic idea behind sex manipulation in cucurbits. The sex ratio and order of flowering are also determined by endogenous amounts of gibberellin, auxins, ethylene and ascorbic acid during the time and set of ontogeny, in addition to the environmental factors.

Being a monoecious plant, bitter gourd naturally produces more male flowers than female flowers. As poor fruit set and yield are a prevalent issue in the production of bitter gourds, this flowering behaviour is not favourable or economical. In order to produce a higher yield, the ratio of male to female flowers need to synchronized. Typically, environmental factors including photoperiod, temperature and nutrition or the application of PGRs can be change can change maleness and femaleness of a plant (Krishnamoorthy, 13).

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PGRs are organic chemicals, other than vitamins and nutrients, which can control plant development when used in minor quantities. In majority of the cucurbitaceous crops auxin, cytokinin, gibberellin, ethylene and abscisic acid are common hormones that trigger flowering in female (Hidayatullah *et al.*, 9). Ethrel is a multipurpose ethylene which releases a chemical hormone that can cause female flowering and boost fruit production in Cucurbitaceous plants. The hormone gibberellin is accountable for internodal length, initiating and boosting male flowering and enhancing protein synthesis. IBA is a synthetic hormone, whereas IAA is a naturally occurring hormone. Apical dominance, control of fruit drops, induction of root, flowering regulation and sex determination are the primary functions of these hormones. By reducing the number of male flowers on the main vine and increasing the number of female flowers on the side branches, growth regulators can boost fruit yield (Mahida *et al.*, 15).

Bitter gourd is one of the important cucurbits which respond more to PGR's and the stages of crops to be spread. Ethephon (2-chloroethyl phosphonic acid) having systemic properties. It is widely used as an exogenous source of ethylene as it decomposes to ethylene which is the active metabolite. Ethephon has been most effective including early female flowers at lower nodes and suppresses the male flower production in bitter gourd (Kalia and Dhillon, 12). In order to observe the effects of different PGRs quality seed yield of bitter gourd, this research was taken to find out best PGR with appropriate concentration for alteration and maximization of quality seed yield of bitter gourd.

MATERIALS AND METHODS

In the *Kharif* season of 2020-21, a field trial was carried out at Horticulture research farm of Bihar Agricultural College, Sabour, Bhagalpur. The soil of the experimental area was sandy loam. The treatment includes three levels of plant growth regulators, *i.e.*, NAA @ 50, 75 and 100 ppm, GA_3 @ 25, 50 and 75 ppm and Ethephon @ 150, 200 and 250 ppm were sprayed in a split plot design with three replications at three different stages S1 (two leaf stage), S2 (two leaf + four leaf stages) and S3 (two leaf + four leaf stages + bud initiation stage) along with the control (water spray) treatment.

After weighing the required quantity of different PGRs were first dissolved with a small quantity of 95% absolute alcohol (solvent) and stock solutions were prepared for each growth regulator by diluting with distilled water. The solutions of the required concentration were then prepared by further dilution of the measured volume of stock solution with distilled water. As per the treatment the crop was sprayed with plant growth regulators (NAA, GA_3 and ethephon) at 2 true leaf stage, 2, 4 true leaf stage and flowering and bud initiation stage. The spray was done with the help of a compressed air hand sprayer in each plot with equal volume during the morning hours of the day. The control plot was sprayed with distilled water.

The seed of bitter gourd were sown at a spacing of 2.0 m × 0.5 m. The recommended dose of fertilizers (NPK) was applied @100:60:60 kg/ha. The full dose of phosphorus and potash fertilizer along with one third dose of nitrogenous fertilizers were applied as basal dose, whereas the residual two third nitrogen doses were applied at 25 days and 50 days after transplanting.

All the recommended cultural packages of practices and plant protection measures were adopted to grow a successful crop. The observation were recorded on 13 characters, namely, *i.e.*, seed weight per fruit (g) , seed yield per vine (g), seed yield per hectare, 100-seed weight (g), seed yield per plot (kg), number of filled seeds per fruit, number of unfilled seeds per fruit, germination percentage, seedling length (cm), seedling dry weight (mg), vigour index-1, vigour index-2 and viability percentage. The experimental data documented from different observation were analyzed in split plot design with three replications for ANOVA (Analysis of Variance). The collected data were subjected for statistical analysis.

RESULTS AND DISCUSSION

The maximum seed weight per fruit (4.97 g) was found with the application of ethephon @ 250 ppm (P9), which was significantly higher than all other treatments followed by ethephon @ 200 ppm (P8). Data regarding seed weight/ fruit was markedly influenced by different stages of spray. The maximum seed weight/ fruit of 4.25 g was obtained with stage S3 followed by stage S2 at 3.90 g. Minimum average fruit weight was obtained when the crop was sprayed at stage S1 (Fig. 1). The interaction of different PGRs and stages of spray (interaction effect) showed significant variation in seed weight/ fruit. The maximum seed weight/ fruit of 5.29 g was observed in the treatment combination of P9 × S3, which was statistically at par with treatment combination P8 × S3 at 5.18 g and P9 × S2 (Table 1).

The enhanced fruit weight in ethrel treatment could be due to the sole function of fertilized ovules in relation to fruit growth with the help of synthesized one or more hormones that initiate and maintain a metabolic gradient with foods that can be transported from other parts of the plant to the fruit. This is

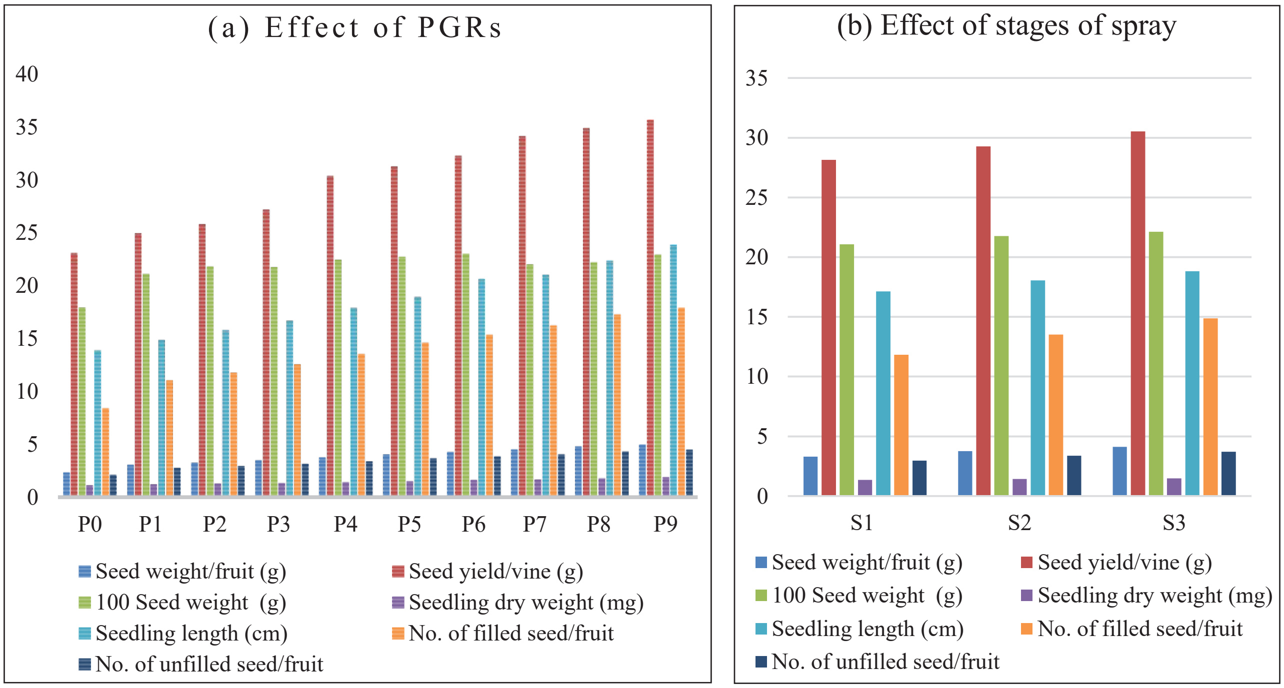

Fig. 1. Effect of PGRs (a) and stages of spray (b) on different growth attributes in bitter gourd.

consistent with Singh and Singh (19) findings on cucumber. These results are also in conformity with the findings of Majid *et al.* (14) on bottle gourd, Kadi *et al*. (11) in cucumber, Soni *et al*. (20) on bottle gourd, Nagamani *et al*. (16) on bitter gourd, Hirpara *et al*. (10) on bitter gourd and Sure *et al*. (21) on pumpkin.

The maximum seed yield/ plot (214.49 g) was recorded in treatment with ethephon @ 250 ppm (P9), which was significantly higher than all other concentrations of PGRs followed by Ethephon @ 200 ppm (P8) giving the seed yield of (209.13 g/ plot). The maximum seed yield per plot (187.67 g) was observed in stage S3, which was statistically higher than the rest of the stages of spray followed by (179.08 g) in stage S2 (Fig. 1). The combination of ethephon @ 250 ppm at stage S3, *i.e.* P9 × S3 showed maximum seed yield/plot (227.47 g), which was significantly higher than all other treatment combinations followed by 212.60 g/ plot seed yield under the treatment combination of P8 × S3 (Table 1).

The reason for increase in seed attributes are due to enhanced number of total female flowers, increased morphological characteristics, *viz*. length of main stem and primary branches and increased metabolic activities resulting in metabolites translocation from source to sink which might have promoted better seeds development. The results of this study are also in line with Arora *et al.* (2) on ridge gourd, Desai *et al.* (5) on watermelon, Gedam *et al.* (7) on bitter gourd, Rashmi (17) on bottle gourd.

Among the PGRs the maximum seedling length (23.85 cm) was recorded in treatment with ethephon @ 250 ppm (P9) followed by ethephon @ 200 ppm (P8) with a seedling length of 22.34 cm. The maximum seedling length (19.39 cm) was observed in stage S3, which was statistically at par with stage S2 (18.63 cm) and significantly superior to control (Fig. 1). The combination of P9 × S3 recorded maximum seedling length (24.52 cm), which was statistically at par with treatment combination P9 × S2 giving seedling length of 23.75 cm (Table 1).

The PGR, which recorded higher seedling length, resulted in more quantity of seedling dry weight. The maximum seedling dry weight (1.86 mg) was recorded with the application of ethephon @ 250 ppm (P9), which was significantly higher than all other concentrations of PGRs followed by ethephon @ 200 ppm (P8) with a dry weight of 1.75 mg. The maximum seedling dry weight (1.53 mg) was obtained with stage S3, which was statistically at par with stage S2 (1.47 mg) and significantly higher than stage S1. The maximum seedling dry weight (1.91 mg) was observed in the treatment combination P9 × S3 which was significantly at par with treatment combination P9 × S2 (1.85 mg) and P8 × S3 (1.82 g) and significantly higher than all other treatment combinations (Table 1).

The maximum number of filled seeds was 17.90, recorded with the application of ethephon @ 250 ppm (P9), which was significantly higher than the rest

Table 1. Interaction effect of PGRs spray at different stages of growth in bitter gourd.

Treatment	SW/F (g)	SY/V (g)	SY/P (g)	SY/H (kg/ha)	NFS/F	NUS/F	100 SW (g)	GP (%)	SL (cm)	SDW (mg)	VI-1	VI-2	V (%)
S1P0	2.18	22.77	227.67	136.60	7.83	1.96	17.58	70.33	12.52	1.03	880.06	72.20	85.06
S1P1	2.73	23.80	238.00	142.80	9.82	2.45	18.75	75.00	14.01	1.14	1051.17	85.25	85.96
S1P2	2.94	24.93	249.33	149.60	10.58	2.64	21.50	86.00	14.72	1.19	1266.39	102.23	86.87
S1P3	3.08	26.10	261.00	156.60	11.10	2.78	21.44	86.30	16.09	1.29	1389.07	111.25	87.97
S1P4	3.30	28.10	281.00	168.60	11.86	2.97	22.08	88.33	17.28	1.38	1526.64	121.55	88.73
S1P5	3.48	29.60	296.00	177.60	12.51	3.13	22.25	89.00	18.05	1.43	1603.40	127.25	89.66
S1P6	3.64	30.90	309.00	185.40	13.09	3.27	22.59	90.37	20.78	1.63	1877.93	147.51	90.46
S1P7	3.98	32.97	329.67	197.80	14.34	3.59	21.68	86.73	19.62	1.55	1701.74	134.20	91.21
S1P8	4.27	34.20	342.00	205.20	15.37	3.84	21.75	87.00	21.11	1.66	1837.25	144.16	91.90
S1P9	4.46	34.27	342.67	205.60	16.05	4.01	22.27	89.07	23.28	1.82	2073.58	161.70	92.60
S2P0	2.30	23.03	230.33	138.20	8.28	2.07	18.03	72.11	14.08	1.14	1014.93	82.28	85.70
S2P1	3.13	24.10	241.00	144.60	11.26	2.81	21.93	87.73	14.81	1.19	1298.79	104.79	86.58
S2P2	3.33	25.30	253.00	151.80	11.99	3.00	21.75	87.00	15.78	1.27	1372.28	110.09	87.48
S2P3	3.49	26.97	269.67	161.80	12.55	3.14	21.92	87.67	16.71	1.33	1462.88	116.80	88.51
S2P4	3.67	31.13	311.33	186.80	13.21	3.30	22.50	90.00	17.90	1.42	1611.52	127.95	89.31
S2P5	4.09	31.50	315.00	189.00	14.73	3.68	22.67	90.67	19.03	1.50	1724.86	136.33	90.38
S2P6	4.35	32.23	322.33	193.40	15.64	3.91	22.92	91.67	20.22	1.52	1853.53	145.86	91.32
S2P7	4.52	34.20	342.00	205.20	16.25	4.06	22.02	88.08	21.39	1.68	1883.60	147.67	92.30
S2P8	4.93	34.93	349.33	209.60	17.75	4.44	22.25	89.00	22.64	1.77	2015.80	157.46	92.97
S2P9	5.18	35.07	350.67	210.40	18.63	4.66	23.00	92.00	23.75	1.85	2184.29	170.13	93.45
S3P0	2.52	23.37	233.67	140.20	9.08	2.27	18.17	72.67	15.06	1.21	1094.90	88.20	86.31
S3P1	3.34	26.97	269.67	161.80	12.01	3.00	22.58	90.33	15.73	1.26	1420.09	113.96	87.51
S3P2	3.53	27.27	272.67	163.60	12.71	3.18	22.17	87.33	16.82	1.34	1468.78	117.20	88.18
S3P3	3.88	28.50	285.00	171.00	13.97	3.49	21.83	88.67	17.32	1.38	1534.06	122.13	89.37
S3P4	4.31	31.83	318.33	191.00	15.52	3.88	22.75	91.00	18.50	1.47	1683.93	133.36	90.19
S3P5	4.59	32.67	326.67	196.00	16.54	4.13	23.25	93.00	19.73	1.56	1835.56	144.69	91.03
S3P6	4.81	33.67	336.67	202.00	17.33	4.33	23.52	93.67	20.84	1.64	1952.20	153.31	92.30
S3P7	5.02	35.17	351.67	211.00	18.05	4.51	22.33	89.33	22.06	1.73	1970.85	154.20	93.07
S3P8	5.18	35.43	354.33	212.60	18.63	4.66	22.58	90.33	23.29	1.82	2103.88	164.06	93.75
S3P9	5.29	37.63	379.67	227.47	19.03	4.76	23.50	94.00	24.52	1.91	2305.02	179.20	94.43
SEm (±)	0.090	0.553	5.546	3.323	0.375	0.097	0.365	1.425	0.394	0.031	47.657	3.601	1.629
C.D @ 5%	0.25	1.57	15.72	9.42	1.06	0.27	1.03	4.04	1.12	0.09	135.12	10.21	4.62

Note : SW/F-Seed weight/fruit, SY/V-Seed yield/vine, SY/P-Seed yield/plot, SY/H-Seed yield/ha, NFS/F-Number of filled seed/fruit, NUS/F-Number of unfilled seed/fruit, 100 SW-100 Seed weight, GP-Germination percentage, SL-Seedling length, SDW-Seedling dry weight, VI-Vigour index-I and II.

of the concentrations of PGRs. The analyzed data showed that the effect of different stages of spray produced significant effect on number of filled seed. Stage S3 produced the maximum number of filled seed of 15.29, which was statistically higher than rest of the stages of spray (Fig. 1). The maximum number of filled seed (19.03) was recorded from the combination P9 × S3, which was statistically at par with the treatment combinations of P9 × S2, P8 × S3 and P7 × S3. However, the minimum filled seed (7.83) was observed with the combination P0 × S1 (Table 1).

Plants treated with PGRs exhibited more vegetative growth, improved photosynthesis and accumulated more food reserves in their seeds resulting in a greater seed yield. Arora and Partap (1) reported similar findings in bitter gourd.

The maximum number of unfilled seed (4.48) was recorded with the application of ethephon @ 250 ppm (P9), which was significantly higher than all other concentrations of PGRs, followed by ethephon @ 200 ppm (P8). The different stages of spray varied significantly by the different stages of spray. The maximum number of unfilled seed (3.82) was obtained with stage S3, which was significantly higher than rest of the stages followed by with 3.51 in stage S2. Minimum unfilled seed (3.06) was recorded in stage S1. The interaction effect showed significant improvement towards number of unfilled seeds. The maximum number of unfilled seed (4.76) was observed in the treatment combination P9 × S3, which was statistically at par with treatment combination P9 × S2 and P8 × S3 and significantly higher than remaining treatment combinations (Table 1).

100-seed weight was influenced significantly due to foliar application of different plant growth regulators. The maximum 100-seed weight (23.01 g) was recorded with the application of GA_3 @ 75 ppm (P6), which was statistically at par with Ethephon @ 250 ppm (P9) and GA_3 @ 50 ppm (P5). The maximum 100-seed weight (22.27 g) was obtained with stage S3, which was statistically at par with stage S2 (21.90 g) and significantly higher than stage S1, which recorded minimum (21.19 g) 100-seed weight. The maximum 100-seed weight (23.52 g) was observed in the treatment combination P6 × S3, which was statistically at par with treatment combination P9 × S3 (23.50 g), P8 × S3, P6 × S3, P6 × S2 and P9 × S2 (Table 1).

The increase in 100-seed weight caused by GA_3 is most likely due to an increase in carbohydrate metabolism, carbohydrates accumulation and enhanced metabolic activity which resulted in higher metabolite translocation from source to sink resulting in improved seed development. The beneficial effects of plant growth regulators on 100-seed weight were also reported by Gedam *et al.* (7) and Arvindkumar *et al*. (3) on bitter gourd. These results are also in line with Shirzad *et al*. (18) who recorded same results with GA_3 @ 25 ppm on pumpkin. The pictorial representation of effect of PGRs and stages of spray on various seed quality attributes has been shown in Fig. 1.

The maximum germination (91.90%) was recorded with treatment of GA_3 @ 75 ppm (P6), which was significantly at par with Ethephon @ 250 ppm (P9) with 91.69%, P5 and P4. Minimum germination of seed (71.70%) was observed in control (P0). The maximum germination (89.03%) was observed in stage S3, which was statistically at par with stage S2 (87.59%) and significantly superior to stage S1, thus recorded minimum (84.81%) germination (Fig. 2). The combination of P9 × S3 showed maximum germination (94%), which was statistically at par with treatment combination P9 × S2, P6 × S3, P5 × S3, P4 × S3, P9 × S2, P6 × S2, P5 × S2, P4 × S2 and P8 × S3, significantly higher than the rest of the treatment combinations (Table 1).

It was found that the seed yield/ vine were significantly affected by foliar application of different PGRs and different stages of spray. The maximum seed yield/vine of 35.66 g was recorded with the application of ethephon @ 250 ppm (P9), which was significantly superior to all other concentrations of PGRs followed by ethephon @ 200 ppm (P8) giving seed yield of 34.86 g/ vine. The highest seed yield/ vine (31.25 g) was obtained with stage S3 (Two leaf + four leaf + bud initiation stages), which was significantly higher than rest of the stages. Minimum seed yield per vine (28.76 g) was recorded under the treatment of foliar spray at two leaf stage (S1). Similarly, interaction effect also brought significant improvement towards seed yield/ vine. The treatment combination P9 × S3 produced maximum seed yield/ vine of 37.63 g, which was significantly higher than all other treatment combinations (Table 1). Increase in the number of female flowers, fruit set and increased metabolic activity which lead to better translocation of metabolites from the source to sink resulted in better development of seeds in bitter gourd (Gedam *et al.*, 7).

The persual of mean data reveals that the seed yield/ ha varied significantly due to foliar application of different PGRs. The maximum seed yield was observed to be 357.67 kg/ha, recorded with the application of ethephon @ 250 ppm (P9), which was significantly higher than all other concentrations of PGRs followed by ethephon @ 200 ppm (P8), which gave 348.56 kg/ ha seed yield; however, the minimum (230.56 kg/ ha) seed yield was observed under control (P0). The different stages of spray caused significant improvement in seed yield of the bitter gourd. The maximum seed yield of 312.83 kg/ ha was obtained with stage S3, which was significantly superior to rest of the stages of spray (Fig. 2). The interaction effect showed a maximum seed yield of 379.67 kg/ ha which was observed in the treatment combination of P9 × S3. This was significantly superior to rest of the treatment combinations followed by the treatment combination P8 × S3, which recorded the seed yield of 354.33 kg/ha (Table 1).

The maximum vigour index I (2187.63) was recorded in treatment with ethephon @ 250 ppm (P9), which was significantly superior to all other

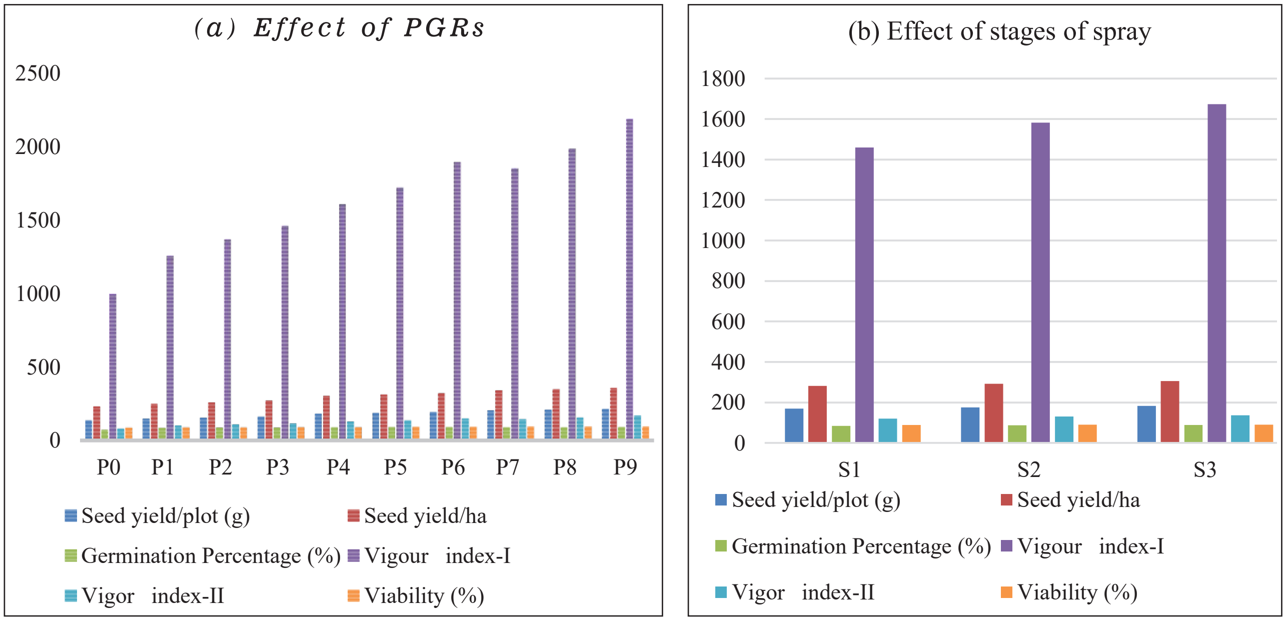

Fig. 2. Effect of PGRs (a) and stages of spray (b) on different growth attributes in bitter gourd.

concentrations of PGRs followed by ethephon @ 200 ppm (P8) with a vigour index of 1985.64. The maximum vigour index I (1736.93) was observed for stage S3, which was statistically at par with stage S2 (1642.25) and significantly higher than stage S1 (Fig. 2). The foliar application of Ethephon @ 250 ppm at stage S3, *i.e.* the combination P9 × S3 recorded maximum vigour index I (2305.02), which was statistically at par with treatment combination P9 × S2 giving vigour index I of 2184.29 and significantly superior to all other treatment combinations (Table 1).

The maximum vigour index II (170.34) was recorded with the application of ethephon @ 250 ppm (P9), which was significantly higher than all other concentrations of PGRs followed by ethephon @ 200 ppm (P8) with vigour index II of 155.22. The minimum (80.89) vigour index II was observed under control (P0). The maximum vigour index II (137.03) was obtained with stage S3, which was statistically at par with stage S2 (129.94) and significantly superior to stage S1, which recorded minimum (120.73) vigour index II. The maximum vigour index II (179.20) was observed in the treatment combination P9 × S3, which was significantly at par with treatment combination P9 × S2 (170.13) and significantly higher than all other treatment combinations (Table 1).

The progressive improvement in parameters under the treatment might be due to the higher value of 100-seed weight or bold seed count, which would have produced healthier seedling and ultimately vigour index I and vigour index II. Similar results having maximum viability (93.50%) was recorded in treatment ethephon @ 250 ppm (P9), which was significantly at par with ethephon @ 200 ppm (P8) and ethephon @ 150 ppm (P7) and significantly higher than all other concentrations of PGRs. The different stages of spray did not produce significant effect on viability of seeds however, the maximum seed viability (90.61%) was observed in stage S3 and minimum was obtained under stage S1. The combination of P9 × S3 recorded maximum seed viability (94.43%), which was statistically at par with treatment combinations P8 × S3, P7 × S3, P6 × S3, P5 × S3, P4 × S3, P9 × S2, P8 × S2, P7 × S2, P6 × S2, P5 × S2, P9 × S1, P8 × S1, P7 × S1 and P6 × S1(Table 1). The pictorial representation of effect of PGRs and stages of spray on various seed quality attributes has been shown in Fig. 2.

On the basis of the result obtained, it can be concluded that significantly maximum seed weight/ fruit (5.29 g), seed yield (379.67 kg/ ha), germination (94 %), seed viability (94.43 %), seedling length (24.52 cm), seedling dry weight (1.91 mg), vigour index I (2305.02), vigour index II (179.20) were found with the application of ethephon @ 250 ppm at two leaf + four leaf + bud initiation stages (P9 × S3), which was almost at par with the spray of ethephon @ 200 ppm at two leaf + four leaf + bud initiation stages (P8 × S3). However, maximum 100 seed weight (23.52 g) was found from the plant sprayed with GA_3 @ 75 ppm at two leaves + four leaves + bud initiation stages (P6 × S3). Thus, it can be concluded that the foliar application of ethephon @ 250 ppm sprayed at two leaf + four leaf + bud initiation stages is beneficial for higher seed yield and better quality seeds in bitter gourd.

The increase in plant growth of bitter gourd can be attributed to cell division and elongation caused by the use of GA_3. GA_3 promotes the mobility of starch particles in the cotyledons and affects the activity of several enzymes, which in turn promotes growth. At higher concentration, GA_3 results in a better yield as at higher concentrations, gibberellic acid can strongly stimulate plant growth processes, *viz*., flower development, cell elongation and stem expansion, thus, producing more seeds, larger fruits and overall increase in plant biomass.

AUTHORS' CONTRIBUTION

Conceptualization of research (SP); Designing of the experiment (SP, RBV); Contribution of experimental materials (SP, RBV); Preparation of the manuscript (SP, RBV).

DECLARATION

The authors declare that there is no conflict of interest.

REFERENCES

1. Arora, S.K. and Partap, P.S. 1988. Influence of foliar application of plant growth regulators on growth, sex expression and yield of watermelon. *Haryana Agri. Uni. J. Res.* **18**: 114-18.

2. Arora, S.K., Pandita, M.L. and Dahiya, M.S. 1989. Effect of plant growth regulators on vegetative growth, flowering and yield of ridge gourd (*Luffa acutangula* Roxb.). *Haryana Agri. Uni. J. Res.* **27**: 319-24.

3. Arvindkumar, P.R., Vasudevan, S.N., Patil, M.G. and Rajrajeshwari, C. 2012. Influence of NAA, triacontanol and boron spray on seed yield and quality of bitter gourd (*Momordica charantia* L.) cv. Pusa Visesh. *Asian J. Hort.* **7**: 36-39.

4. Behra, T.K. 2004. Heterosis in bitter gourd. *J. New Seeds* **6**: 217-22. https://doi.org/10.1300/J153v06n02_11

5. Desai, U.T., Shinde, H.J., Choudhari, S.M. and Kale, P.N. 1994. Effect of growth regulators on quality of watermelon fruits. *Indian J. Hort.* **51**: 285-87.

6. Dostogir, H., Karim, M.A., Pramanik, M.H.R. and Rehman, A.A.M.S. 2006. Effect of gibberellic acid (GA_3) on flowering and fruit development of bitter gourd (*Momordica charantia* L.). *Int. J. Bot.* **2**: 329-32.

7. Gedam, V.M., Patil, R.B., Suryawanshi, Y.B. and Mate, S.N. 1998. Effect of plant growth regulators and boron on flowering, fruiting and seed yield in bitter gourd. *Seed Res.* **26**: 97-100.

8. Grubben, G.J.H. 1977. *Tropical Vegetable and their Genetic Resources*, IBPGR, Rome. pp. 51-52.

9. Hidayatullah, T.M, Farooq, M., Khokhar, M.A. and Hussain, S.I. 2012. Plant growth regulators affecting sex expression of bottle gourd (*Lagenaria siceraria* Molina) plants. *Pakistan J. Agric. Res.* **25**: 50-54.

10. Hirpara, J.A., Vaddoria, M.A., Jivani, L.L., Patel, J.B. and Polara, A.M. 2014. Seed yield and quality as influence by plant growth regulators and stages of spray in bitter gourd. *AGRES- An Int e-J.* **3**: 282-87.

11. Kadi, A.S., Asati, K.P., Barche, S. and Tulasigeri, R.G. 2018. Effect of different plant growth regulators on growth, yield and quality parameters in cucumber (*Cucumis sativus* L.) under polyhouse condition. *Int. J. Curr. Microbiol. Appl. Sci.* **7**: 3339-52.

12. Kalia, H.R. and Dhillon, H.S. 1964. Alternation in genetic pattern of sex ratios in *Lagenaria siceraria* stand1 by asafetida a new sex regulant. *Punjab Agri. Uni. J. Res.* **1**: 30-40.

13. Krishnamoorthy, H.N. 1981. *Plant growth Substances*. Tata McGraw-Hill Publishing Company Ltd. New Delhi pp. 169-75.

14. Majid, A.A. and Chowdhary, B.M. 2018. Effects of boron and plant growth regulators on bottle gourd (*Lagenaria siceraria* (Molina) Standle.). *J. Pharmacogn. Phytochem.* **7**: 202-06.

15. Mahida, S.V., Valia, R.Z. and Sitapara, H.H. 2015. Growth yield and sex expression as influenced by plant growth regulator in sponge gourd cv. Pusa Chikni. *Asian J. Hort.* **10**: 122-25.

16. Nagmani, S., Basu, S., Singh, S., Lal, S.K., Behera, T.K., Chakrabarty, S.K. and Talukdar, A. 2015. 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 J. Agri. Sci.* **85**: 1185-91.

17. Rashmi, P. and Bendale, V.W. 2003. Effect of plant growth regulators on flowering and yield of

okra (*Abelmoschus esculentus* (L.) Moench.). *J. Soil Crop.* **12**: 238-41.

18. Shirzad, S., Hosein, A. and Majid, A. 2012. Influence of plant growth regulators (PGRs) and planting method on growth and yield in oil pumpkin (*Cucurbita pepo* var. *styriaca*). *Notulae Scientia Biologicae* **4**: 101-07.

19. Singh, R.K. and Singh, G.P. 1984. Effect of growth regulators on sex expression sex ratio and yield in cucumber (*Cucumis sativus* L.). *Veg. Sci.* **11**: 15-20.

20. Soni, S., Singh, K.V. and Dalai, S. 2016. Impact of foliar application of plant bio-regulators on yield traits and economics of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] *Res. Environ. Life Sci.* **9**: 497-501.

21. Sure, S., Arooie, H. and Azizi, M. 2013. Effect of GA_3 and Ehtephon on sex expression and oil yield in medicinal pumpkin (*Cucurbita pepo* var. *styriaca*). *Int. J. Farming Allied Sci.* **9**: 196-201.

(Received : December, 2024; Revised : March, 2025; Accepted : March, 2025)