Vegetable Science (2022) 49(1):109-112

Short Communication

Effect of different PGRs and stages of spray on growth attributes of bitter gourd

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Received: February 2022/ Accepted: May 2022

Bitter gourd (*Momordica charantia* L.) is one of the most important vegetable crops of the Cucurbitaceae family which is cultivated round the year. In India, it is one of the leading vegetable crops and the crop is preferred by the farmers because of its higher yield and returns (Kumar et al. 2012). It is usually cultivated for edible fruit, which is the most bitter amongst all vegetables. It has export potential due to its great keeping quality, it has also export potentiality. It is highly valued for its nutritional content such as carbohydrates, proteins, vitamins and minerals, particularly iron and ascorbic acid (Behera 2004), as well as several medicinal properties, when compared to other cucurbitaceous crops (Alam et al. 2009). The fruit and juice have been used for treating diabetes. Maleness is a common problem in bitter gourd as it is in other cucurbits, and it significantly decreases the fruit and seed yields. Plant growth regulators (NAA, GA_3, and Ethrel) are a new category of agrochemicals that transform the normal growth right from the germination of seed to senescence in the crop plants, when used in small amounts. Growth regulators increase the number of female flowers and fruits in bitter gourd, resulting in improved seed yield and quality. Plant growth regulators improve the root activity and plasticity of cell wall, allowing for better nutrient absorption and enhancement in fruit growth and yield. Bitter gourd is one of the important cucurbits that respond well to PGRs and the stages of crops. Plant growth regulators such as GA_3, NAA and Ethephon have the potential to modify sex ratios, plant growth and yield contributing features (Shantappa et al. 2007). GA_3 plays a critical role in enhancing metabolic activity, which leads to increased metabolites translocation from source to sink, ultimately resulting in improved seed development and an increase in 100-seed weight (Hirpara et al. 2014). Gibberellic acid is an essential growth regulator that may have various uses to modify the plant growth, yield and yield contributing features (Rafeekher et al. 2002). The majority of gibberellins effects are only exposed when they are combined with auxins. Ethephon (2-chloroethyl phosphonic acid) is an ethylene-releasing compound which is commonly used as plant growth regulator. Application of ethephon reduces the length of stem in different cucurbits plants (Thappa et al. 2011; Sure et al. 2013; Shakar et al. 2015). Ethephon has a promotion effect on plant growth parameters such as number of leaves and fresh and dry weight of the plant (Ezzo et al. 2012 and Glala et al. 2012). In bitter gourd, ethephon has been efficient in inducing early female flowers at lower nodes and suppressing the male flower production. Auxin (NAA) is a crucial plant growth regulator that promotes cell elongation, cell enlargement and cell division in the apical region of plant, leading to better plant growth (Pandey et al. 1986). Use of PGRs might be a beneficial option to increase crop production. The importance of PGRs in improving crop production has recently been realized globally. The present study was under taken to find out the effect of different PGRS and stages of spray on growth attributes of bitter gourd.

A field experiment was conducted at Horticulture Research Farm, Bihar Agricultural College, Sabour, Bihar during the kharif season 2020-21 with three replication in split plot design. There were two test factors, one was the plant growth regulators and the second was different stages of spray. The seed were sown in field with 2.0×0.5 m. Three seeds per hill were sown. After germination, the seedlings were thinned and only one healthy seedling per hill was kept. The fertilizers were applied @ 100:60:60 kg/ha for N:P:K respectively. One third of nitrogen in the form of Urea was applied as basal dose while full dose of P_2O_5 and K_2O was applied as basal dose in form of SSP (Single Super Phosphate) and MOP (Murate of Potash), respectively. The residual

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dose of nitrogen was top-dressed in two equal split doses i.e. one third at 25 days and at 50 days of transplanting. Standard plant protection measures were adopted as and when required. Growth regulators application treatments include P0 (Control i.e. no application of any PGRs), P1 (NAA @ 50 ppm), P2 (NAA @ 75 ppm), P3 (NAA @ 100 ppm), P4 (GA_3 @ 25 ppm), P5 (GA_3 @ 50 ppm), P6 (GA_3 @ 75 ppm), P7 (Ethephon @ 150 ppm), P8 (Ethephon @ 200 ppm) and P9 (Ethephon @ 250 ppm) applied at three different stages S1 (two leaf stage), S2 (two leaf + four leaf stages) and S3 (two leaf + four leaf + flowering and bud initiation stages). Five plants were randomly selected from each treatment for recording the growth attributes. Data was collected on various growth attributes viz. length of internodes, number of branches/plot, fruit length and fruit diameter. The data was analyzed statistically by the application of ANOVA (Analysis of Variance) in split-plot design.

The effect of stages of spray and PGRS and the interaction effect of PGRs on different growth attributes in bitter gourd are depicted in Table 1 and 2, respectively. The results of various growth attributes are discussed below in detail.

Effect on length of internodes: The analyzed data showed that the effect of different stages of spray produced significant effect on length of internodes. The maximum length of internodes (12.92 cm) was observed in stage S3 which was statistically at par with stage S2 (12.42 cm). However, the lowest (11.83 cm) length of internodes was obtained under S1. All the PGRs produced significantly higher internodal length than the control treatment. Among PGRs the maximum (15.90 cm) length of internodes was recorded for treatment P9 sprayed with Ethephon @ 250 ppm, which was statistically higher than all other concentrations of PGRs. The interaction effect due to the stages of spray and PGRs was found significant on length of internodes. The foliar application of Ethephon @ 250 ppm with treatment combination P9 × S3 showed maximum length of internodes (16.34 cm), which was statistically at par with treatment combination of P9 × S2.

Effect on number of branches: The different stages of spray as well as the growth regulators produced significant response on number of branches/plant. The maximum number of branches/ plant (13.92) was obtained with stage S3, which was statistically at par with stage S2 (13.42) and significantly higher than stage S1. Among PGRs, the application of Ethephon @ 250 ppm in treatment P9 (Ethephon @ 250), recorded maximum number of branches (16.90), which was statistically higher than all others concentrations of PGRs. The interaction effect showed the treatment combination P9 × S3 being statistically at par with the treatment combination P9 × S2 and produced significantly maximum number of branches/ plant (17.34) than all other treatment combinations. The increase in number of branches/plant might be due to increase in nutrient uptake, more photosynthetic activity and translocation efficiency leading to rapid cell division, elongation and vegetative growth (Mangal et al. 1981).

Effect on fruit length: The average length of fruit was markedly influenced due to different stages of spray and PGRs. The maximum fruit length (13.14 cm) was

Table 1: Effect of stages of spray and PGRs on different growth attributes in bitter gourd

Treatments	Length of internodes (cm)	Number of branches per plant	Fruit length (cm)	Fruit diameter (cm)
Stages of spray				
S1	11.83	12.83	10.62	3.23
S2	12.42	13.42	11.74	3.57
S3	12.92	13.92	13.14	3.98
SEm (±)	0.184	0.201	0.174	0.065
C.D (P=0.05)	0.72	0.79	0.68	0.25
Plant Growth Regulators				
P0 (Control)	9.25	10.25	9.03	2.74
P1 (NAA @ 50 ppm)	9.90	10.90	10.46	3.17
P2 (NAA@ 75 ppm)	10.52	11.52	11.35	3.44
P3 (NAA @ 100 ppm)	11.14	12.14	11.56	3.50
P4 (GA_3 @ 25 ppm)	11.93	12.93	11.49	3.48
P5 (GA_3 @ 50 Ppm)	12.62	13.62	12.15	3.68
P6 (GA_3 @ 75 ppm)	13.74	14.74	12.41	3.76
P7 (Ethephon @ 150ppm)	14.01	15.01	12.97	3.94
P8 (Ethephon @ 200 ppm	14.89	15.89	13.30	4.04
P9 (Ethephon @ 250 ppm	15.90	16.90	13.62	4.18
SEm (±)	0.111	0.112	0.218	0.063
C.D (P=0.05)	0.31	0.32	0.62	0.18

Table 2: Interaction effect of PGRs spray on growth attributes in bitter gourd

Treatments	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	SEm and CD 5%
Length of internodes (cm)											
S1 stage	8.34	9.34	9.81	10.73	11.52	12.03	13.85	13.08	14.07	15.52	SEm (±) =0.295
S2 stage	9.38	9.87	10.52	11.14	11.93	12.69	13.48	14.26	15.09	15.84	C.D = 0.73
S3 stage	10.04	10.48	11.21	11.55	12.33	13.15	13.89	14.71	15.52	16.34	
Number of branches per plant											
S1 stage	9.34	10.34	10.81	11.73	12.52	13.03	14.85	14.08	15.07	16.52	SEm (±) =0.272
S2 stage	10.38	10.87	11.52	12.14	12.93	13.69	14.48	15.26	16.09	16.83	C.D = 0.77
S3 stage	11.04	11.48	12.21	12.55	13.33	14.15	14.89	15.71	16.52	17.34	
Fruit length (cm)											
S1 stage	8.37	9.25	9.82	10.32	10.76	11.31	11.43	11.50	11.68	11.73	SEm (±) =0.399
S2 stage	9.00	9.87	11.00	11.35	11.54	12.36	12.57	13.14	13.22	13.40	C.D = 1.13
S3 stage	9.72	12.26	13.24	13.01	12.16	12.78	13.24	14.28	15.02	15.74	
Fruit diameter (cm)											
S1 stage	2.54	2.80	2.98	3.13	3.26	3.43	3.46	3.50	3.54	3.62	SEm (±) =0.122
S2 stage	2.73	2.99	3.33	3.44	3.50	3.75	3.81	3.98	4.04	4.14	C.D = 0.35
S3 stage	2.95	3.71	4.01	3.94	3.69	3.87	4.01	4.33	4.55	4.77	

obtained with stage S3, which was significantly superior to rest of the stages. Among the various concentrations of PGRs, treatment P9 (Ethephon @ 250), was at par with treatment P8 (13.30 cm) and statistically higher than all other concentrations with a maximum fruit length of 13.62 cm. The interactions effect revealed that the maximum fruit length of 15.74 cm was observed in the treatment combination P9 × S3, which was statistically at par with treatment combination P8 × S3 (15.02 cm) and significantly higher than all other treatment combinations. Higher cell division and cell elongation along with increased metabolic activity might be the reason for rise in fruit length. Fruit length and diameter have the most direct impact on fruit yield.

Effect on fruit diameter: The fruit diameter was significantly influenced by the foliar application of different PGRs and the different stages of spray. The maximum fruit diameter (3.98 cm) was obtained with stage S3, which was significantly higher than rest of the stages of spray. The maximum fruit diameter (4.18 cm) was recorded for treatment P9 (Ethephon @ 250), which was statistically at par with treatment P8 (Ethephon @ 200 ppm) and significantly higher than all other concentrations. The interaction effect of different PGRs and stages of spray also showed significant improvement in diameter of fruit. The maximum fruit diameter (4.77 cm) was observed in the treatment combination P9 × S3, which was significantly at par with treatment combination P8 × S3 (4.55 cm) and significantly higher than all other treatment combinations. Ethrel enhanced the endogenous Auxin levels, which causes a diametric elongation of fruit cells, resulting in increased fruit diameter (Sandra et al. 2015 and Ghani et al. 2013).

On the basis of the result obtained, it can be concluded that significantly maximum length of internodes (16.34 cm), number of branches/ plant (17.34), fruit length (15.74 cm) and fruit diameter (4.77 cm) were found with the application of Ethephon @ 250 ppm at S3 stage (P9 × S3), which was almost at par with the spray of Ethephon @ 200 ppm at S3 stage (P8 × S3). Thus, the study indicates that various growth attributes of bitter gourd were influenced by the foliar application of growth regulators and different stages of spray.

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