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Study of influence of PGRs and stages of spray on yield and economics of bitter gourd

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Abstract
A field experiment was conducted to study the effect of PGRs spray on quality seed yield at different growth stages in bitter gourd during Kharif 2020 at Horticulture research farm of Bihar Agricultural College, Sabour, Bhagalpur. 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 average fruit weight (140.08 g) and number of fruits/ vine (10.41). Highest gross return (Rs. 683400 /ha), net return (Rs 565362 /ha) and B: C ratio (4.79) were obtained when the plants were sprayed with Ethephon @ 250 ppm at stage S3 followed by stage S2**.** Hence, it may be concluded that foliar application of Ethephon @ 250 ppm sprayed three times at two leaf stage, four leaf stage and bud initiation stage would be beneficial for higher yield as well as net return with higher B: C ratio.

Keywords: Bitter gourd, plant growth regulators, seed yield

Introduction
Bitter gourd (*Momordica charantia* L.) is a tropical and subtropical vegetable of the family Cucurbitaceae. It is widely grown for edible fruit, which is the most bitter among all vegetables. The species' origins are unknown, but it is a native of the tropics. It is widely grown in South and Southeast Asia, China, and Africa. The herbaceous tendril-bearing vine grows to 5 m. Each plant bears separate yellow male and female flowers. Bitter gourd considered as nutrition rich fruit vegetable, which contains considerable amount of water (83-92%), carbohydrates (4.0-10.5%), protein (1.5-2.0%), fat (0.2-1.0%), minerals (0.5-1.0%) and fiber (0.8-1.7%). 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 plant growth regulators are well known as a new generation agrochemicals after fertilizers, herbicides and pesticides. GA_3, NAA, and Ethephon are essential plant growth regulators with the potential to change plant growth, sex ratios, and yield contributing characters (Shantappa *et al.* 2007) [11]. Growth regulators enhance the number of female flowers and fruits that lead to increase the seed yield and quality in bitter gourd. Though a number of improved varieties are available in India, an efficient seed production package is lacking especially aimed at manipulating the sex ratio for enhance seed yield and quality. GA_3 plays vital role in increasing metabolic activity leading to higher translocation of metabolites from source to sink points, which ultimately results in better development of seeds and increase in 100-seed weight (Hirpara *et al*. 2014) [3]. The beneficial effects of plant growth regulators on seed yield and 100- seed weight have also reported by Gedam *et al*. (1998) [2] and Arvindkumar *et al*. (2012) [1] in bitter gourd.

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, 1964) [5]. Gibberellic acid (also called Gibberellin, GA and GA_3) is a phytohormone, which is required in small quantity for the growth and development of plants. Most effects of gibberellins are shown only in concert with auxins. Auxin (NAA) is a vital plant growth regulator, which stimulates cell elongation, cell enlargement and cell division in apical region of plant resulting in better plant growth (Pandey *et al*. 1986) [10]. Spraying of gibberellin @ 75 mgl^{-1} at 4 leaf stage significantly affected the vegetative and reproductive growth (flowering) which resulted in increased fruit as well as seed yield in medicinal pumpkin (Sure *et al*. 2013) [14].

Materials and Methods

The field experiment was carried out Horticulture research farm of Bihar Agricultural College, Sabour, Bhagalpur during the kharif season during 2020-21. The geographical location of Bhagalpur comes under the Middle Gangetic plain region of Agro-climatic Zone III (A) in Bihar. It is situated between 25°50' N latitude and 87°19' E longitude at an altitude of 52.73 meters above mean sea level. The soil of the experimental plot was sandy loam. The field experiment was laid out in split plot design replicated three (3) times. Out of the two test factors, one is the levels of plant growth regulators and the second one is different stages of spray. The present investigation was framed with 30 treatment combinations comprising of nine concentrations of PGRs NAA (P1- 50 ppm, P2- 75 ppm, P3-100 ppm), GA_3 (P4- 25 ppm, P5-50 ppm, P6-75 ppm) and Ethephon (P7- 150 ppm, P8-200 ppm, P9 - 250 ppm) along with control (P0) and three stages of plant growth (S1- two leaf stage, S2- two leaf + four leaf stages and S3- two leaf + four leaf stages + bud initiation stages). Seeds were planted in pits with a row spacing of 2 m and a plant spacing of 0.5 m. Treatment wise full dose of phosphorus (P_2O_5), full dose of potash (K_2O) and 1/3rd of nitrogen as urea was applied as basal dose. As per treatment the residual dose of nitrogen was top-dressed in two equal split doses i.e., one third at 25 days of transplanting and the rest amount at 50 days of transplanting.

Results and discussion

The interaction effect of foliar application of different plant growth regulators and stages of spray was found significant for number of fruits/vine. The foliar application of Ethephon @ 250 ppm (P9) at S3 (Two leaf + four leaf+ bud initiation stages) recorded maximum number of fruits/vine, which was statistically at par with Ethephon @ 250 ppm (P9) at S2 (Two leaf + four leaf stages). The possible reason for more numbers of fruits /vine might be due to earlier emergence and greater establishment of seedlings. Increased fruit output in treated plants might support the theory that plants need to be physiologically active in order to accumulate enough assimilates for growing flowers and fruits, resulting in increased yield. Additionally, Ethephon increased fruit output is most likely owing to an increase in carbohydrate metabolism and carbohydrate build up Mishra *et al*. (1972) [8] in bottle gourd.

The foliar application of different plant growth regulators and stages of spray showed significant variation in average fruit weight. The maximum average fruit weight was found with the application of Ethephon @ 250 (P9) at stage S3 (Two leaf + four leaf + bud initiation stages), which was at par with treatment Ethephon @ 200 (P8) at stage S3 (Two leaf + four leaf + bud initiation stages). 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 consistent with Singh and Singh's (1984) [12] findings in cucumber. These results are also in conformity with the findings of Majid *et al*. (2018) [6] in bottle gourd, Kadi *et al*. (2018) [4] in cucumber, Soni *et al*. (2016) [13] in bottle gourd, Nagamani *et al*. (2015) [15] in bitter gourd, Hirpara *et al*. (2014) [3] in bitter gourd and Sure *et al*. (2013) [14] in pumpkin.

The interaction effect of plant growth regulators and stages of spray produced significant increase in gross return, net return and benefit: cost ratio (table 1). The seed produced from the plant sprayed with Ethephon @ 250 ppm applied at stage S3 gave highest gross return, net return and benefit: cost ratio. This might be because of greater number of fruits/vine resulting in a higher quantity of seed yield than other treatments. These findings are consistent with those of Mehdi *et al*. (2012) [7], which found that a greater dosage of Ethrel sprayed on cucumber for maximum production yielded better outcomes.

Table 1: Effect of PGRs spray at different stages of growth on Gross return, Net returns and B: C ratio of Bitter gourd

Treatments	Number of fruits/vine	Average fruit weight (g)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
Stages of spray					
S1	7.70	90.21	517740	400972.00	3.44
S2	8.04	103.27	537240	419246.80	3.56
S3	8.35	112.52	563100	443880.00	3.73
SEm (±)	0.116	1.336	5818.92	5818.92	0.050
C.D (P=0.05)	0.46	5.25	22844.66	22844.66	0.19
Plant Growth Regulators					
P0(Control)	6.15	61.80	415000	294310	2.44
P1 (NAA @ 50 ppm)	6.49	81.18	449200	332110	2.84
P2 (NAA@ 75 ppm)	6.91	86.55	465000	347710	2.96
P3 (NAA @ 100 ppm)	7.28	92.30	489400	371910	3.16
P4 (GA_3 @ 25 ppm)	7.76	99.60	546400	428710	3.64
P5 (GA_3 @ 50 Ppm)	8.17	107.41	562600	443910	3.74
P6 (GA_3 @ 75 ppm)	8.84	113.01	580800	461110	3.85
P7 (Ethephon @ 150ppm)	9.01	119.37	614000	497004.7	4.25
P8 (Ethephon @ 200 ppm	9.54	126.99	627400	510294	4.36
P9 (Ethephon @ 250 ppm	10.14	131.79	643800	526594	4.49
SEm (±)	0.070	1.195	4936.71	4936.71	0.042
C.D (P=0.05)	0.20	3.39	13977.19	13977.19	0.12

Conclusion

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 yield as well as net return with higher B: C ratio.

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