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Effect of plant growth regulators on yield and economics of bottle gourd (*Lagenaria siceraria* (Molina) Standl)

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Abstract
An experiment was conducted in bottle gourd to study the effect of three plant growth regulator (PGR) viz., gibberellic acid (GA_3), Naphthalene acetic acid (NAA) and ethrel for growth trait, fruit characters and economics of bottle gourd. Foliage application of Ethrel @ 200 ppm was found beneficial for number of fruits per vine, fruit yield (kg/vine), days to 1st harvest, whereas maximum fruit length, fruits weight and fruits girth was obtained by the application of distilled water however maximum vine length, total number of node per vine was obtained by the foliage application of GA_3 @ 150 ppm. Based on these observations, it could be suggested that the significant increase in growth and fruit characters would be obtained by the spraying of ethrel 200 ppm at 2 and 4 true leaves.

Keywords: Plant growth regulator (PGRs), growth trait, distilled water, naphthalene acetic acid and foliage application

Introduction
Bottle gourd *Langeraria sicenaria* (monlina) standl.) is a photo-insensitive crop but sensitive to thermoperiodism. Thus, most of the existing bottle gourd varieties are season specific. It is rich in vitamin 'B' and source of minerals viz., P, Ca and Fe. It is also important for medicinal use as ion case of headache, urines trouble and jaundice. Bottle gourd production has been increased considerably to meet the increasing internal demands as well as to open the export market abroad. The yield of cucurbit depends to a great extent on sex expression and sex ratio. Early nodes bear male flowers and higher amounts whereas hermaphrodites and pistillate flowers are found in later nodes. These results in delaying harvesting as well as yield reduction. The problem can be defeat by exogenous application of PGRs. PGRs directly affect male and female flower ratio, fruit set, fruit drop and ultimately effects yield (Bose *et al* 1999). Therefore, the use of PGRs like NAA, Ethrel and GA_3 in bottle gourd may become an important tool for yield increase as well as timely harvest. Sharma *et al*. (1998) revealed that spray of NAA increased vine length, female flowers and yield in bottle gourd. Ethrel is used for more number of female flowers due to its property of better development of gynoecium, fruit ripening, stress induction, lateral cell expansion (Taiz and Zeiger, 2002). The increase in female flowers, fruit and yield in bottle gourd with application of Ethrel has been reported by Belhelkar *et al*. (2006). GA_3 are responsible for shoot growth by enhancing cell elongation and cell division.

Materials and Methods
The field trial was conducted at vegetable section of Horticulture garden under the faculty of agriculture, Agricultural University Sabour, Bhagalpur, Bihar, India during Rabi season 2018-19 which is geographically situated between 25 ^{0}C' 15'40''N latitude to 87°2'42''Elongitude at 46 m above mean sea level. The climate of this place is tropical to sub-tropical with slight semi-arid nature and is characterized by very dry summer, moderate rainfall and very cold winter. During growing season, the maximum and minimum temperatures were recorded to be 33.3 ^{0}C and 5.6 ^{0}C, respectively. Soil of the field was well drained sandy-loam in nature with rich in organic matter with good fertility status. Leveled soil surface with assured irrigation facility with expected winter and summer rain during the cropping period. The experimental material consisted of Narendra Rashmi cultivar of bottle gourd, which is released from Main Vegetable Research Station NDAU and T Faizabad, U.P. Experiment was laid out in Randomized Block Design with three replications. Three PGRs viz., GA (gibberellic acid), Naphthalene acetic acid (NAA)) and ethrel (2-chloroethyl phosphoric acid) were used for

study. Seed treatment by carbendazim solution@ 0.2 % for 12 hours in combination with two sprays of each PGR at 2 and 4 true leaf stages with the Altogether 10 treatment combination was made for the field trial. Plant geometry of 3.0 x 0.5 m was maintained with pit planting of 10 seed sowing in each pit. Pit was dug before 15 days of planting with 30 x 30 x 30 cm^3 and applied 20 ton/ha compost, 120 kg/ha N, 60 kg/ha p and 60 kg/ha K. Recommended package of practices was followed to raise the normal crops. Data were recorded on 14 important characters related to Growth and fruit characters during the course of investigation which were subjected to statistical analysis using suitable techniques of different characters. The technique of analysis of variance for randomized block design (factorial) was adopted following Panse and Sukhatme (1967) [10].

Results and Discussion

The analysis of variance for various attributes revealed significant differences among the PGRs. it can be concluded that the foliage application of Ethrel @ 200 ppm was found beneficial for number of fruits per vine, fruit yield (kg/vine), days to 1st harvest, whereas maximum fruit length, fruits weight and fruits girth was obtained by the application of distilled water however maximum vine length, total number of node per vine was obtained by the foliage application of GA_3 @ 150 ppm.

Fruit Character

With respect to fruit characters, PGR showed significant effect (Table 2). Ethrel -200ppm significantly reduced days to first harvesting (54.00 days) which was statistically at par with the treatment T_6 NAA -150 ppm (58.00 days), T_5 NAA 100 ppm (57.66 days), T_4 NAA- 50ppm (56.78 days), T_3 Ethrel 300ppm (55.33 days) and T_1 Ethrel 100ppm (54.58 days).

Length of fruit increased significantly with PGR maximum (37.86 cm) long fruits with the application of distilled water (control) (Table 2). The maximum diameter of fruit (29.22 cm) was recorded by application of distilled water which showed significant effect.

Average maximum fruit weight (1.48kg) was increased significantly by the application of distilled water which was statistically at par with T_2 Ethrel 200 ppm (1.45 kg) and T_3 Ethrel 300 ppm (1.40 kg). PGR significantly increased number of fruits per vine and Ethrel 200 ppm gave maximum (10.36 fruit/vine). The highest Fruit yield (kg/ vine) was recorded in treatment T_2 Ethrel 200 ppm (15.02 kg) which was statistically at par with treatment T_3 Ethrel 300 ppm (13.79 kg). The data revealed that fruit yield of bottle gourd per plot was significantly increased by various treatments. The maximum fruit yield per plot was recorded in treatment T_2 Ethrel 200 ppm (70.28 kg) which was statistically at par with treatment T_3 Ethrel 300 ppm (65.39 kg).

The increased number of fruits per vine (Mandai *et al.* (1990) [8] and Kumar *et al*. (2006) [5] in bottle gourd), Fruit yield (kg/ vine) (Parmar (2003) [9] in sponge gourd), days to first harvesting and yield of bottle gourd per plot (These findings are also in consonance with those of Arora *et al*. (1988) in sponge gourd; Das and Maurya (1993) [4] in pumpkin) by application of Ethrel 200 ppm.

Table 1: Effect of plant growth regulators on fruit character

Chemical	Concentration	Days to first harvesting	Fruit Length (cm)	Fruit diameter (cm)	Avg fruit weight (kg)	No of fruit per vine	Fruit yield (Kg/ vine)	Yield/ Plot
Ethrel	100 ppm	54.80	34.86	27.64	1.32	8.66	11.43	55.15
Ethrel	200 ppm	54.00	36.62	27.84	1.45	10.36	15.02	70.28
Ethrel	300 ppm	55.33	35.16	28.16	1.40	9.78	13.69	65.39
NAA	50 ppm	56.78	34.08	26.21	1.30	7.85	10.20	49.84
NAA	100 ppm	57.66	33.26	25.70	1.25	7.58	9.47	46.78
NAA	150 ppm	58.00	31.06	22.26	1.15	7.46	8.58	43.04
GA_3	50 ppm	60.66	33.54	25.86	1.28	7.65	9.79	48.12
GA_3	100 ppm	61.33	32.12	24.35	1.18	7.42	8.75	43.75
GA_3	150 ppm	63.66	30.74	21.18	1.12	7.18	8.04	40.77
Distilled water spray (control)	-	59.60	37.86	29.22	1.48	6.84	10.12	49.51
S.Em. ±		2.558	1.647	1.324	0.060	0.374	0.701	3.140
C.D. at 5%		5.375	3.461	2.782	0.128	0.786	1.473	6.597
C.V. %		5.39	5.95	6.28	5.77	5.68	8.17	7.50

Economics of Different Treatments

The net profit rupees per hectare was worked out from the fruit yield of bottle gourd by taking into consideration the prevailing price of bottle gourd in the market and inputs used. Among the different treatments of plant growth regulators significantly higher net returns (378906 Rs/ha) and B: C ratio (4.24) was obtained under the use of ethrel 200 ppm (T_2).

Table 2: Economics of different treatments in bottle gourd

Treatments	Cost of distilled water @ Rs.10/litre for 400 litre water (Rs.)	Cost of 4 labour @ Rs. 257/Lb (Rs.)	Quantity of chemical	Cost of chemical (Rs.)	Total treatment cost (Rs.)	Cost of production due to treatment
Ethrel 100 ppm	4000.00	1028.00	25 ml	41.25	5069.00	89440
Ethrel 200 ppm	4000.00	1028.00	50 ml	82.50	5111.00	89482
Ethrel 300 ppm	4000.00	1028.00	75 ml	123.75	5152.00	89523
NAA 50 ppm	4000.00	1028.00	25 ml	120.00	5148.00	89519
NAA 100 ppm	4000.00	1028.00	50 ml	240.00	5268.00	89639
NAA 150 ppm	4000.00	1028.00	75 ml	360.00	5388.00	89759
GA_3 50 ppm	4000.00	1028.00	25 gram	3500.00	8528.00	92899
GA_3 100 ppm	4000.00	1028.00	50 gram	7000.00	12028.00	96399
GA_3 150 ppm	4000.00	1028.00	75 gram	10500.00	15528.00	99899
Control	4000.00	1028.00	-	-	5028.00	89399

Rate (Rs.):
Ethrel – Rs. 1.65/ml
NAA – Rs. 4.80/ml
GA_3 – Rs. 140.00/gram

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