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Effect of plant growth regulators on growth and seed yield of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]

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Abstract
An experiment on "Effect of plant growth regulators on growth and seed yield of bottle gourd" was carried out during summer season, 2018. The experiment was laid out in randomised block design (Factorial) with three levels of NAA (50 ppm, 75 ppm, 100 ppm), GA_3 (50 ppm, 75 ppm, 100 ppm) and Ethrel (100 ppm, 200 ppm, 300 ppm) and control (P0- distilled water spray) sprayed at three stages (S1 - At two true leaf stage, S2 - 1st at two true leaf stage and 2nd at four true leaf stage and S3 - 1st at two true leaf stage, 2nd at four true leaf stage and 3rd at flower initiation stage) and replicated thrice. The results reveal that the interaction between different PGRs and stages of spray showed significant effect. The maximum vine length (6.25 m), number of nodes per vine (46.40), node number to first male flower appearance (7), node number to first female flower appearance (9.40), number of primary branches (11.80), number of fruit/vine (4.80), internodal length (7.90 cm) and seed yield (465.22 kg/ha) with foliar application of Ethrel @ 300 ppm at stage S3 (1st at two true leaf stage, 2nd at four true leaf stage and 3rd at flower initiation stage). Significantly highest fruit length (61.70 cm) was observed when plant sprayed with GA3 @ 75 ppm at stage S3 (1st at two true leaf stage, 2nd at four true leaf stage and 3rd at flower initiation stage) and the maximum fruit diameter (11.26 cm) was obtained when plant sprayed with NAA @ 100 ppm at two true leaf stage (S1). Therefore, it may be concluded that foliar application of Ethrel @ 300 ppm sprayed at different stages of growth i.e. at two true leaf stage, four true leaf stage and flower initiation stage was beneficial for higher seed yield and better growth of plant.

Keywords: Plant growth regulators, stages of spray, seed and growth

Introduction
Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is commonly grown vegetable in India and belongs to family Cucurbitaceae. It shows cardiatonic and diuretic in effect. The pulp is good for decreasing the cough, nightblindness, constipation, and act as antidote against certain poisons. It also cure those people who is suffering from biliousness and indigestion. The plant growth regulators are well known as a new generation agrochemicals after fertilizers, herbicides and pesticides. GA_3, NAA & Ethrel are important plant growth regulators that may have ability to alter the growth, sex ratios and yield contributing characters of plant (Shantappa *et al.* 2007) [11].

The discovery of plant growth regulators has been considered as a revolution in the history of agriculture as it has brought amazing vast new possibilities of delicate and wonderful adjustment and development pattern in plants. A growth regulator enables to man to control the plant growth and has become the greater tool in the hands of horticulturist for enhancing yield and better quality of vegetables. Plant growth regulators have immense potential for growth improvement but their application has to be planned sensibly in terms of optimal concentration, stages of application, species specificity and seasons. The use of plant growth regulators at suitable stage play an important role in sex expression and ultimately yield of bottle gourd (Sircar, 1971) [10]. In case of cucurbits, the gowth regulators are more important due to their outstanding effect on staminate and pistillate flowers ratio, fruit set, fruit drop and ultimately on yield (Bose *et al.* 1999) [3].

Seed is the basic and cheapest input and forms only a small part of the total cultivation expenses. Yet, without good seed the investment on fertilizers, water, pesticides and other inputs will not pay the required dividends. Hence, good agriculture depends upon good seed and vice-versa.

Materials and Methods

The present investigation was framed with three levels of NAA (50 ppm, 75 ppm, 100 ppm), GA3 (50 ppm, 75 ppm, 100 ppm) and Ethrel (100 ppm, 200 ppm, 300 ppm) along with control (P0- distilled water spray) and three stages of spray (S1 - At two true leaf stage, S2 - 1st at two true leaf stage and 2nd at four true leaf stage and S3 - 1st at two true leaf stage, 2nd at four true leaf stage and 3rd at flower initiation stage). The experiment was conducted in RBD (Factorial) with three replications. The spacing of plants were kept 2m x 1m. The recommended package and practices were followed for healthy growth and development of the plants. The variety of bottle gourd was Narendra Rashmi. The research work was undertaken at vegetable seed production area under department of Horticulture (Vegetable & Floriculture), BAU, Sabour, Bhagalpur during summer season, 2018 on variety Narendra Rashmi.

Table 1: Effect of Stages of spray and PGRs on Growth and Seed yield

	VL(m)	NN/V	NNFMF	NNFFF	NPB/V	NF/V	IN(cm)	FL(cm)	FD(cm)	SY(Kg/ha)
Stages of spray										
S1	5.31	32.78	10.55	13.64	8.42	3.36	9.58	52.72	10.05	344.92
S2	5.5	35.96	10.26	13.20	9.02	3.52	9.55	54.79	9.61	355.07
S3	5.63	37.04	10.13	13.14	9.15	3.64	10.01	56.32	9.29	372.15
Mean	5.48	35.26	10.31	13.33	8.83	3.51	9.71	54.61	9.65	357.38
SEm(±)	0.007	0.08	0.02	0.03	0.02	0.01	0.03	0.13	0.02	0.74
C.D.(P=0.05)	0.020	0.24	0.06	0.08	0.05	0.03	0.07	0.37	0.06	2.11
P0(control)	4.43	27.27	12.60	15.77	6.20	2.67	12.18	54.26	9.65	301.34
P1(NAA 50 ppm)	4.69	33.97	10.67	13.87	7.50	3.30	9.03	51.60	10.17	334.15
P2(NAA 75 ppm)	4.66	36.47	10.00	13.20	8.33	3.47	9.13	52.69	10.11	347.09
P3(NAA 100 ppm)	4.9	36.17	10.87	13.93	8.67	3.40	9.18	52.07	10.37	347.77
P4(GA_3 50 ppm)	5.63	32.03	11.33	14.50	8.63	3.27	10.28	57.49	9.00	313.12
P5(GA_3 75 ppm)	6.54	34.43	11.37	14.60	8.97	3.17	10.51	59.27	8.58	348.31
P6(GA_3 100 ppm)	6.34	34.17	11.07	14.20	9.47	3.13	11.17	58.40	8.83	354.20
P7(ETHREL 100 ppm)	5.66	33.97	9.53	12.00	9.50	3.80	8.73	51.08	10.45	376.08
P8(ETHREL 200 ppm)	5.89	40.70	8.13	11.13	10.37	4.33	8.47	54.17	9.76	416.40
P9(ETHREL 300 ppm)	6.02	43.43	7.57	10.07	11.00	4.53	8.43	55.08	9.58	435.34
Mean	5.58	35.26	10.31	13.33	8.83	3.51	9.71	54.61	9.65	357.38
SEm(±)	0.023	0.28	0.07	0.10	0.06	0.03	0.08	0.44	0.08	2.48
C.D.(P=0.05)	0.066	0.78	0.21	0.28	0.16	0.09	0.24	1.24	0.21	7.02

VL - Vine length (m), NN/V- Number of nodes/vine, NNFMF- Node number to first male flower, NNFFF- Node number to first female flower, NPB/V- Number of primary branches/vine, NF/V- Number of fruits/vine, IN-Internodal length (cm), FL- Fruit length (cm), FD-Fruit diameter (cm), SY-Seed yield (Kg/ha).

Table 2: Interaction effect of stages of spray and PGRs on Growth and Seed Yield

Treatments	VL(m)	NN/V	NNFMF	NNFFF	NPB/V	NF/V	IN(cm)	FL(cm)	FD(cm)	SY(Kg/ha)
P0 x SI	4.27	26.20	12.20	15.20	6.20	2.40	11.40	56.15	9.24	299.29
P0 x S2	4.45	27.00	12.60	15.50	5.60	2.60	12.15	55.64	9.36	308.91
P0 x S3	4.57	28.60	13.00	16.60	6.80	3.00	13.00	51.00	10.35	295.82
P1 x S1	4.73	32.60	12.00	15.20	7.30	3.10	8.85	53.34	9.75	318.47
P1 x S2	4.55	34.60	9.80	12.80	7.70	3.30	9.00	51.28	10.26	334.16
P1 x S3	4.78	35.10	10.20	13.60	7.50	3.50	9.25	50.18	10.50	349.82
P2 x S1	4.45	34.10	9.60	13.00	8.00	3.20	8.80	50.46	10.70	329.92
P2 x S2	4.68	37.10	10.00	13.20	8.40	3.80	9.10	52.42	10.16	347.68
P2 x S3	4.85	38.20	10.40	13.40	8.60	3.40	9.50	55.20	9.48	363.67
P3 x S1	4.60	35.20	10.40	13.60	8.20	3.60	9.00	47.98	11.26	337.82
P3 x S2	5.17	36.10	11.20	14.20	8.80	3.20	9.20	49.81	11.00	348.74
P3 x S3	4.93	37.20	11.00	14.00	9.00	3.40	9.35	58.42	8.85	356.76
P4 x S1	5.55	30.80	11.60	14.80	8.50	3.50	9.75	53.16	9.85	316.58
P4 x S2	5.33	32.20	11.30	14.50	8.80	3.30	10.10	60.36	8.46	296.82
P4 x S3	6.02	33.10	11.10	14.20	8.60	3.00	11.00	58.96	8.70	325.95
P5 x S1	6.63	32.10	11.50	14.80	8.30	3.20	10.85	56.48	9.08	344.72
P5 x S2	6.80	35.10	11.80	15.20	9.00	3.00	9.15	59.64	8.50	355.46
P5 x S3	6.18	33.10	10.80	13.80	9.60	3.30	11.50	61.70	8.16	344.76
P6 x S1	5.75	33.20	11.40	14.60	9.20	2.80	10.40	59.62	8.56	343.81
P6 x S2	6.70	34.10	10.80	13.80	9.40	3.20	11.10	55.15	9.58	315.12
P6 x S3	6.58	35.20	11.00	14.20	9.80	3.40	12.00	60.42	8.35	403.68
P7 x S1	5.58	32.20	10.00	12.00	9.10	3.60	9.10	50.14	10.60	365.79
P7 x S2	5.42	34.60	9.60	11.80	9.60	3.80	8.70	52.49	10.00	377.46
P7 x S3	5.97	35.10	9.00	12.20	9.80	4.00	8.40	50.60	10.76	384.99
P8 x S1	5.68	32.60	8.60	12.00	9.60	4.00	8.75	49.36	10.85	393.24
P8 x S2	5.87	44.10	8.00	11.40	11.50	4.40	8.40	54.54	9.65	425.19
P8 x S3	6.12	45.40	7.80	10.00	10.00	4.60	8.25	58.62	8.78	430.78
P9 x S1	5.80	38.80	8.20	11.20	9.80	4.20	8.90	50.48	10.58	399.61

P9 x S2	6.00	45.10	7.50	9.60	11.40	4.60	8.50	56.62	9.15	441.18
P9 x S3	6.25	46.40	7.00	9.40	11.80	4.80	7.90	58.14	9.00	465.22
SEm(±)	0.070	0.83	0.22	0.29	0.17	0.10	0.25	1.31	0.23	7.44
C.D.(P=0.05)	0.198	2.35	0.62	0.83	0.47	0.27	0.72	3.71	0.64	21.06

Results and Discussion

The significant differences were observed for main effect of PGRs and stages of spray as well as their interaction effect on most of the characters studied (Table 1 and 2). The highest vine length (6.80 m) were produced by the sprayed with GA3 (75 ppm) at stage S2 (2+4 true leaf stage) which was statistically similar to GA3 (100 ppm) applied at stage S2 and GA3 (75 ppm) at stage S1 (two true leaf stage) having vine length of 6.70 m and 6.63 m respectively and minimum vine length (4.27 m) was recorded under control (sprayed with distilled water) at stage S1 (two true leaf stage). Foliar application of GA3 caused in higher vine length and internodal length due to greater stem elongation, a stimulatory action of GA. According to Mangal *et al.* (1981) [5], the increase in vine length may be attributed to increase in nutrient uptake, higher photosynthetic activity and translocation efficiency resulting in rapid cell division, elongation and vegetative growth. The interaction effect due to PGRs and Stages of spray also gave significant effect on number of nodes per vine. The plant sprayed with Ethrel @ 300 ppm at stage S3 (2+4 true leaf stage and flower initiation stage) showed the highest number of node per vine (46.40) which was stastistically similar to Ethrel @ 300 ppm sprayed at stage S2 (2+4 true leaf stage) (45.10), and also with treatment P8S3 (45.40) and P8S2 (44.10). The minimum number of nodes/vine (26.20) was found with treatment P0S1. The interaction effect due to PGRs and stages of spray also gave significant effect on number of primary branches per vine. The plant sprayed with Ethrel @ 300 ppm at 2+4 true leaf stage and flower initiation stage produced the highest number of primary branches per vine (11.80) which was statistically similar to treatment P9S2 (11.40) and P8S2 (11.47). The minimum number of primary branches/vine (5.60) was noted with treatment P0S2. Foliar application of Ethrel caused significant decrease in vine length and induction of dwarfism had resulted enhanced number of primary branches and number of nodes per vine. These are in close agreement with earlier findings of Arora and Pratap (1988) [1] with foliar spray of Ethrel in pumpkin. The significantly lowest number of node to 1st male flower (7.00) was found due to the combined effect of foliar application of Ethrel @ 300 ppm at stage 3 (2+4 true leaf stage and at flower initiation stage), followed by application of Ethrel @ 300 ppm sprayed at stage S2, giving the node number to 1st male flower on 7.50. Maximum node number to 1st male flower (13.00) was appeared when distilled water sprayed at stage S3 (2+4 true leaf stage and at flower initiation stage). The lowest number of node to 1st female flower (9.40) was observed when plant sprayed with Ethrel @ 300 ppm at stage S3 (2+4 true leaf stage and flower initiation stage) which was stastistically similar to Ethrel @ 300 ppm sprayed at stage S2 (2+4 true leaf stage) producing the first female flower on 9.60th node. The highest number of node (16.60) produced first female flower under water spray at 2+4 true leaf stage and flower initiation stage. Foliar application of all PGRs under study were found significant in reducing the number of nodes for initiation of 1st male and female flowers which might be due to enhancement of starch and carbohydrates. Least node number to first female flower appeared was observed when plant sprayed with 300 ppm of Ethrel. These results are in accordance with the earlier findings of Thappa *et al.* (2011) [12] and Shafeek *et al.* (2016) [9]. Plant with the presence of Ethrel completes its vegetative growth at quicker rate and come in reproductive stage earlier which resulted in reduction in number of days to appearance of first pistillate flower. The minimum internodal length (7.90 cm) was noticed in the treatment combination P9S3 (P9-Ethrel 300 ppm and S3- 2+4 true leaf stage and flower initiation stage) which behaved statistically similar to treatment combination with P9S2, P8S3, P7S3 and P8S2 producing internodal length of 8.50 cm, 8.23 cm, 8.40 cm and 8.38 cm respectively and the highest internodal length (13.00 cm) was recorded with treatment P0S3. Minimum intermodal length was reported with application of Ethrel (Rudich *et al.* 1970 and Anon 1970) which might be due to iso-dimeric enlarged in girth of vine. The treatment P9S3 (P9-Ethrel 300 ppm and S3- 2+4 true leaf stage and flower initiation stage) was found significantly superior with highest number of fruits/vine (4.80) which was stastistically equal footing to treatment P9S2, P8S2 and P8S3, giving the number of fruits/vine 4.60, 4.40 and 4.60, respectively and minimum (2.40) in treatment POS1. The possible reason for more number of fruits per vine might be due to transformation male buds into female flower with the foliar spray of Ethrel. The highest fruit length (61.70 cm) was found in treatment P5S3 (P5- GA3 75 ppm and S3- 2+4 true leaf stage and flower initiation stage) which was at par to treatment P4S3, P6S3, P6S1 and P4S2, producing the fruit length of 58.96 cm, 60.42 cm, 59.64 cm and 60.36 cm, respectively and minimum (47.98 cm) was observed with foliar application of NAA @ 100 ppm (P3) at stage S1. The interaction effect due to stages of spray and PGRs was found Significant on fruit diameter. The foliar application of NAA @ 100 ppm (P3) at two leaf stage (S1) showed maximum fruit diameter (11.26 cm) and followed by treatment P3S2 having fruit diameter of 11.00 cm and minimum (8.16 cm) was found in treatment (P5S3). Mc Combs (1956) also reported that the larger size of fruit was due to an increase in cell division and cell elongation as well as increased metabolic activity under the influence of chemical stimulates heavy fruits might be due to more carbohydrate accumulation due to increased photosynthesis.

The interaction effect due to stages of spray and PGRs was found significant on seed yield. The foliar application of Ethrel @ 300 ppm at stage S3 (2+4 true leaf stage and flower initiation stage) showed highest seed yield (465.22 kg/ha) followed by application of Ethrel @ 200 ppm at stage S2 (2+4 true leaf stage) producing seed yield of 441.18 kg/ha and minimum (299.29 kg/ha) was found in treatment (P0S1) *i.e.* when plant sprayed with distilled water at two leaf stage. The highest seed yield was found maximum due to higher number of fruits per vine. These results are in agreement with the finding of Gedam *et al*. (1996). Spraying of PGRs can change the morphology of plants and enhancing the metabolic activity lead to higher accumulation of food reserves in the fruit and seeds favouring higher seed yield. These effects of PGRs was noticed by Rafeekher *et al.* **(**2002).

Conclusion

It can be concluded that spray of Ethrel @ 300 ppm at three stage *i.e.* S3 (two true leaf stage, four true leaf stage and

flower initiation stage) was found beneficial for higher seed yield, number of fruits/vine, number of nodes/vine, number of primary branches/vine and least number of internodal length, nodes at 1st male flower appearance and 1st female flower appearance whereas foliar application of Ethrel @ 200 ppm applied at stage S2 (2+4 true leaf stage) ranked second in merit.

However maximum fruit length was recorded in fruit produced under the foliar spray of GA3 @ 75 ppm applied at stage S3 (2+4 true leaf stage and flower initiation stage) while maximum fruit diameter (1.26 cm) was obtained from plant sprayed with NAA @ 100 ppm applied at stage S1 (two true leaf stage). The maximum vine length was recorded under the foliar spray of GA3 @ 75 ppm applied at stage S2 (2+4 true leaf stage).

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