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Effect of foliar application of plant growth regulators and boron on growth and sex expression of Bottle Gourd (*Lagenaria siceraria* (Mol.) Standl.) in Chhattisgarh Plains

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ABSTRACT

The present investigation entitled “Effect of foliar application of plant growth regulators and boron on growth flowering and sex expression of Bottle Gourd (*Lagenaria siceraria* (Mol.) Standl.) in Chhattisgarh Plains” was conducted during kharif-2026 at the Instructional cum Research Farm, MGUVV, Sankara-Patan, Durg Chhattisgarh, where adequate facilities for irrigation and drainage exist. The experiment was laid out in Factorial randomized block design (RBD) with four replications and fifteen treatments. The test Bottle gourd varieties taken were “Kashi Ganga”.

It was found that Ethrel @ 200 ppm (P_4) most effective plant growth regulator in most growth and flowering parameters. It has the maximum vine length (6.25 m), minimum node at first male flower (8.79), minimum node at first female flower (11.87), earliest appearance of male flower (42.663 days) and female flower (47.80 days), maximum male flowers (73.01 plant⁻¹) and female flowers (21.43 plant⁻¹) and the lowest sex ratio (3.40). Boron @ 0.2% was best in all other parameters recorded, having the least node at first male flower (10.25), node at first female flower (12.83), the earliest male flower (47.60) and female flower (53.69) and maximum female flower (17.90 plant⁻¹).

The interaction Ethrel @ 200 ppm + boron @ 0.2% (P_4M_2) showed the maximum numerical vine length (6.80 m), the lowest number of nodes to the first male and female flowers (8.64 and 11.40), the earliest male and female flowering (42.03 and 46.64 days) and the highest female flowers/plant (21.73 plant⁻¹) while the lowest sex ratio (3.37).

Keywords: Bottle Gourd, Growth and Flowering Parameter

Introduction

Bottle gourd (*Lagenaria siceraria*) belongs to the family Cucurbitaceae, has a chromosome number of $2n = 22$, is believed to have originated in tropical Africa, and was domesticated in both Africa and Asia (Sabu *et al.*, 2022) [1]. It is widely known by various names, including calabash gourd, white-flowered gourd, Lauki, Kadu, Ghiya, and Doodhi (Gajera *et al.*, 2017) [2]. Bottle gourd, with the scientific name *Lagenaria siceraria* (Mol.) Standl., belongs to the genus *Lagenaria*, a name originating from the Latin term “lagena,” which means bottle. Although earlier texts may have identified it as *Lagenaria vulgaris* or *Lagenaria leucantha*, the officially recognized name today is *Lagenaria siceraria* (Acharya *et al.*, 2020) [3]. Bottle gourd, commonly known as lauki or doodhi, is a nutritious, low-calorie vegetable with a high-water content. It provides carbohydrates, small amounts of protein and fat, and dietary fibre. It is also a source of minerals such as calcium, iron, magnesium, and potassium, along with vitamin C. Due to its high-water content and low energy value, bottle gourd can contribute to hydration and is commonly included in a balanced diet. It is also easy to digest and can be prepared in a variety of dishes. Fruits are long peduncled, big, fleshy-watery, very variable as to shape and size, depressed globose, oblong-ellipsoid, 20-100 cm long and 10-15 cm in diameter. The fruit contain 0.2 per cent protein, 2.9 per cent carbohydrates, 0.5 per cent fat, 0.5 per cent mineral matter, 0.044 mg thiamine, 0.023 mg riboflavin, 0.33 mg niacin and 12 mg vitamin C, 0.6 g fibre per 100 g fresh weight (Aykrod, 1963) [4].

The total production of bottle gourd in India for the year 2024-25 was 3.81 megatons. Bihar is the top bottle gourd-producing state in India, with a production of 0.664 megatons for the year 2024-25. Other top bottle gourd-producing states in India include Madhya Pradesh, Uttar Pradesh, Punjab, Gujarat and Haryana. (Anonymous, 2024) [5]. Chhattisgarh is in the fifth position in bottle gourd production in India. Chhattisgarh has a total production of 258.83 thousand metric tonnes of bottle gourd in 2024-25 over an area of 14.666 thousand metric tonnes, contributing 6.79% to India's total bottle gourd production. The main bottle gourd-producing regions are Raipur, Bilaspur, and Durg. (Anonymous, 2024) [6].

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Plant growth regulators Ethrel is a versatile ethylene-releasing agent that has remarkable market value and is registered for several crops. The application of ethrel for inducing female flowers in cucurbits is very common. It reduces the stem length and increases female flowering, ultimately increasing the number of fruits per vine of cucurbits. Its use in modifying fruit size and other morphological traits, as well as yield, has also been reported by various workers like (Arora *et al.*, 1998) [7]. Boron plays a significant role in the growth and development of bottle gourd, which has been observed by many scientists. Application of boron in bottle gourd also significantly increased yield due to increased number of female flower and fruit set as well as fruit size (Hooda *et al.*, 1981) [8]

Material and Method

The experiment was carried out during *Rabi* season 2025-26 in the Instructional cum Research Farm under College of Horticulture and Research Station, Sankara-Patan Durg (C.G.). The field experiment was conducted in factorial randomized block design with three replications and fifteen treatments viz., No PGR + No micronutrient (T₁), 0.1% boron (T₂), 0.2% boron (T₃), NAA @ 100 ppm (T₄), NAA @ 100 ppm + boron @ 0.1% (T₅), NAA @ 100 ppm + boron @ 0.2% (T₆), NAA @ 200 ppm (T₇), NAA @ 200 ppm + boron @ 0.1% (T₈), NAA @ 200 ppm + boron @ 0.2% (T₉), Ethrel @ 100 ppm (T₁₀), Ethrel @ 100 ppm + boron @ 0.1% (T₁₁), Ethrel @ 100 ppm + boron @ 0.2% (T₁₂), Ethrel @ 200 ppm (T₁₃), Ethrel @ 200 ppm + boron @ 0.1% (T₁₄) and Ethrel @ 200 ppm + boron @ 0.2% (T₁₅). The experimental field was ploughed twice with a cultivator, followed by levelling and manual weeding. Well-rotted farm-yard manure (FYM) was incorporated into the soil at the time of bed preparation. The experimental plots were laid out using measuring tape, rope and bamboo pegs. Seeds were sown in rows and covered with a thin layer of coarse sand and garden soil. Germination occurred within 5–6 days after sowing. Water was applied with watering cans on alternate days. Five plants at random were selected from each plot and tagged in order to record the observations on vine length (cm), minimum node at first male flower (days) node at first female flower, male flower (days), female flower (days) and sex ratio.

Result and Discussion

Growth parameter

The study of comparison of plant growth regulators and boron management and interaction between the two factors with 15 treatment on significantly influenced of growth and flowering parameter *i.e.* vine length (cm), minimum node at first male flower (days) node at first female flower, male flower (days), female flower (days) and sex ratio are presented in table 1.

Vine length (m)

Maximum vine length was obtained in Ethrel @ 200 ppm with the value of 6.25 m, followed by NAA @ 200 ppm with 5.37 m. The vine length recorded under Ethrel @ 100 ppm and Control was 4.67 and 4.46 m, respectively, whereas the least vine length was recorded in NAA @ 100 ppm with the value of 4.34 m. Among the boron management options, highest vine length was obtained in Boron @ 0.1% with the value of 5.20 m, which was at par with Boron @ 0.2% with 5.16 m, whereas the least vine length was recorded in control with the value of 4.70 m.

The interaction between plant growth regulators and boron management options was found to be significant. The results showed that highest vine length was obtained in Ethrel @ 200 ppm + Boron @ 0.2% with the value of 6.80 m, followed by Ethrel @ 200 ppm + Boron @ 0.1% with 6.17 m and Ethrel @ 200 ppm + Control with 5.79 m. The least vine length was recorded in Control + Control with 3.80 m.

The increase in vine length with application of Ethrel @ 200 ppm might be attributed to its favourable influence on vegetative growth

and physiological processes, resulting in better shoot elongation and overall plant growth. The beneficial effect of boron application on vine growth may be associated with its role in cell division, cell wall development and translocation of assimilates, which favoured better vegetative growth. The superior performance of the combined treatment P₄M₂ might be due to the complementary effect of Ethrel and boron on vegetative growth and development. The present finding is supported by Kumar *et al.* (2020) [9], Rahman *et al.* (2020) [10] and Sabu *et al.* (2022) [11] in bottle gourd.

Node at first male flower

Among the plant growth regulator treatments, the lowest node at first male flower was recorded in P₄- Ethrel @ 200 ppm (8.79), followed by P₂- NAA @ 200 ppm (9.42). The highest node at first male flower was recorded in P₀- Control (12.32), followed by P₁- NAA @ 100 ppm (11.56), whereas P₃- Ethrel @ 100 ppm recorded 10.627 nodes. Among the boron management treatments, the lowest node at first male flower was recorded in M₂- Boron @ 0.2% (10.26), which was on par with M₁- Boron @ 0.1% (10.57). The highest node at first male flower was recorded in M₀- Control (10.801).

The interaction effect between plant growth regulators and boron management was found to be non-significant. However, numerically, the lowest node at first male flower was recorded in P₄M₂- Ethrel @ 200 ppm + Boron @ 0.2% (8.64), followed by P₄M₁- Ethrel @ 200 ppm + Boron @ 0.1% (8.80) and P₂M₂- NAA @ 200 ppm + Boron @ 0.2% (9.07). The highest node at first male flower was recorded in P₀M₀- Control + Control (12.58), followed by P₀M₁ (12.39) and P₀M₂ (11.99).

The reduction in node number at first male flower with Ethrel application may be attributed to its favorable influence on reproductive development and early induction of

flowering. Boron application may have further supported flower initiation and reproductive development through its role in cell division, pollen development and translocation of assimilates. Thus, the combined application of Ethrel @ 200 ppm with boron @ 0.2% resulted in earlier appearance of male flowers at a lower node. The present findings are in agreement with Kumar *et al.* (2020) [9], Rahman *et al.* (2020) [10] and Sabu *et al.* (2022) [11] in bottle gourd.

Node at first female flower

Among the plant growth regulator treatments, the lowest node at first female flower was recorded in P₄- Ethrel @ 200 ppm (11.87), followed by P₂- NAA @ 200 ppm (12.47) and P₃- Ethrel @ 100 ppm (12.89). The highest node at first female flower was recorded in P₀- Control (15.03), followed by P₁- NAA @ 100 ppm (13.80). Among the boron management options, the lowest node at first female flower was recorded in M₂- Boron @ 0.2% (12.83), followed by M₁- Boron @ 0.1% (13.17), whereas the highest value was recorded in M₀- Control (13.64).

The interaction between plant growth regulators and boron management was found to be non-significant. Numerically, the lowest node at first female flower was recorded in P₄M₂- Ethrel @ 200 ppm + Boron @ 0.2% (11.40), followed by P₄M₁- Ethrel @ 200 ppm + Boron @ 0.1% (12.00) and P₄M₀- Ethrel @ 200 ppm + Control (12.23). The highest node at first female flower was recorded in P₀M₀- Control + Control (16.10), followed by P₀M₁ (14.70) and P₀M₂ (14.30).

The lower node number at first female flower under Ethrel application may be associated with accelerated reproductive development and earlier floral initiation. The beneficial effect of boron may be attributed to its involvement in reproductive growth, flower development and efficient movement of photosynthates towards developing reproductive organs. The combined treatment of Ethrel @ 200 ppm with boron @ 0.2% therefore resulted in the earliest appearance of female flowers at a lower node. These results are in accordance with the findings of Kumar *et al.* (2020) [9], Rahman *et al.* (2020) [10] and Sabu *et al.* (2022) [11] in bottle gourd.

Days to first appearance of male flower

Among the plant growth regulator treatments, the minimum number of days to first appearance of male flower was recorded in P₄- Ethrel @ 200 ppm (42.663 days), followed by P₂- NAA @ 200 ppm (45.130 days) and P₃- Ethrel @ 100 ppm (47.997 days). The maximum number of days was recorded in P₀- Control (53.063 days), followed by P₁- NAA @ 100 ppm (52.473 days). The boron management options, the minimum number of days to first appearance of male flower was recorded in M₂- Boron @ 0.2% (47.600 days), followed by M₁- Boron @ 0.1% (48.286 days), while the maximum was recorded under M₀- Control (48.910 days).

The interaction between plant growth regulators and boron management was found to be non-significant. However, numerically, the earliest appearance of male flower was recorded in P₄M₂- Ethrel @ 200 ppm + Boron @ 0.2% (42.03 days), followed by P₄M₁- Ethrel @ 200 ppm + Boron @ 0.1% (42.43 days) and P₄M₀- Ethrel @ 200 ppm + Control (43.53 days). The latest appearance of male flower was recorded in P₀M₀- Control + Control (53.35 days).

The earlier appearance of male flowers under Ethrel @ 200 ppm may be attributed to its influence on physiological processes associated with floral initiation and reproductive development. The application of boron may have further favoured flower initiation by improving reproductive growth and translocation of assimilates. Consequently, the combined application of Ethrel @ 200 ppm and boron @ 0.2% resulted in the earliest appearance of male flowers. The present findings are in agreement with Duhan *et al.* (2022) [11] and Sabu *et al.* (2022) [1] in bottle gourd.

Days to first appearance of female flower

Among the plant growth regulator treatments, significantly minimum days to first appearance of female flower were recorded in P₄- Ethrel @ 200 ppm (47.80 days), followed by P₂- NAA @ 200 ppm (53.42 days) and P₃- Ethrel @ 100 ppm (55.10 days). The maximum number of days to first appearance of female flower was recorded in P₀- Control (58.13 days), followed by P₁- NAA @ 100 ppm (57.12 days). Among the boron management options, the minimum number of days to first appearance of female flower was recorded in M₂- Boron @ 0.2% (53.69 days), followed by M₁- Boron @ 0.1% (54.40 days), whereas the maximum was recorded in M₀- Control (54.85 days).

The interaction between plant growth regulators and boron management was found to be non-significant. However, numerically, the earliest appearance of female flower was recorded in P₄M₂- Ethrel @ 200 ppm + Boron @ 0.2% with 46.64 days, followed by P₄M₁- Ethrel @ 200 ppm + Boron @ 0.1% with 48.04 days and P₄M₀- Ethrel @ 200 ppm + Control with 48.73 days. The latest appearance of female flower was recorded in P₀M₀- Control + Control (58.49 days), followed by P₀M₁ (58.11 days) and P₀M₂ (57.79 days).

The earlier appearance of female flowers with Ethrel application may be attributed to its favourable influence on reproductive growth and modification of the sex expression towards female flowering. The beneficial effect of boron may be associated with its role in reproductive development, cell division and translocation of assimilates towards developing floral organs. The combined application of Ethrel @ 200 ppm with boron @ 0.2% therefore resulted in earlier initiation of female flowers. The present findings are in accordance with Barot *et al.* (2023) [12], who reported that Ethrel application was beneficial for reducing the days required for appearance of the first female flower in bottle gourd.

Number of male flowers per plant

Among the plant growth regulator treatments, significantly highest number of male flowers per plant was recorded in P₄- Ethrel @ 200 ppm (73.017), followed by P₂- NAA @ 200 ppm with 71.727 male flowers plant⁻¹. P₃- Ethrel @ 100 ppm recorded 65.767 male flowers plant⁻¹, followed by P₁- NAA @ 100 ppm with 56.742 male flowers plant⁻¹. The minimum number of male flowers per plant was recorded in P₀- Control (49.787). Among the boron management options, the highest number of male flowers per plant was recorded in

M₂- Boron @ 0.2% (65.108), followed by M₁- Boron @ 0.1% (63.358), whereas the minimum number was recorded under M₀- Control (61.757).

The interaction between plant growth regulators and boron management was non-significant. Numerically, the maximum number of male flowers per plant was recorded in P₄M₂- Ethrel @ 200 ppm + Boron @ 0.2% (73.25), followed by P₄M₁ (72.96) and P₄M₀ (72.84). The minimum number of male flowers per plant was recorded in P₀M₀- Control + Control (45.02).

The increase in the number of male flowers under Ethrel application may be related to the influence of growth regulators on floral differentiation and sex expression in cucurbits. However, the response to Ethrel may vary with concentration, genotype and environmental conditions. Boron application may have enhanced reproductive development by improving cell division, flower development and assimilate movement. The present finding is supported by Barot *et al.* (2023) [12], who reported a favourable influence of Ethrel application on the number of male flowers in bottle gourd and also Rahman *et al.* (2020) [10], who reported significant effects of plant growth regulators and trace elements, including boron, on flowering behaviour and reproductive traits of bottle gourd.

Number of female flowers per plant

Among the plant growth regulator treatments, significantly highest number of female flowers per plant was recorded in P₄- Ethrel @ 200 ppm (21.43), followed by P₂- NAA @ 200 ppm (20.42) female flowers plant⁻¹. P₃- Ethrel @ 100 ppm recorded (16.87) female flowers plant⁻¹, followed by P₁- NAA @ 100 ppm (14.85). The minimum number of female flowers per plant was recorded in P₀- Control (13.53). Among the boron management treatments, significantly maximum number of female flowers per plant was recorded in M₂- Boron @ 0.2% (17.90), followed by M₁- Boron @ 0.1% (17.39), whereas the minimum number was recorded in M₀- Control (16.96).

The interaction between plant growth regulators and boron management was non-significant. Numerically, the maximum number of female flowers per plant was recorded in P₄M₂- Ethrel @ 200 ppm + Boron @ 0.2% (21.73), followed by P₄M₁ (21.44) and P₄M₀ (21.12). The minimum number of female flowers per plant was recorded in P₀M₀- Control + Control (12.93).

The increase in female flower production with Ethrel application may be attributed to its role in modifying sex expression and promoting female floral development in monoecious cucurbits. Enhanced boron availability may have further supported reproductive growth through improved pollen and flower development, cell division and translocation of photosynthates. The present result is in close agreement with the findings of Seni *et al.* (2025) [13], who reported that Ethrel @ 200 ppm was most effective for increasing the number of female flowers per plant in bottle gourd under Chhattisgarh Plains.

Sex ratio

Among the plant growth regulator treatments, the lowest sex ratio was recorded in P₄- Ethrel @ 200 ppm (3.40), followed by P₂- NAA @ 200 ppm (3.51). P₀- Control recorded a sex ratio of 93.67, while P₁- NAA @ 100 ppm recorded (3.81). The highest sex ratio was recorded in P₃- Ethrel @ 100 ppm (3.90). Among the boron management options, the sex ratio varied only slightly. The lowest sex ratio was recorded in M₀- Control (3.65), followed by M₂- Boron @ 0.2% (3.66) and M₁- Boron @ 0.1% (3.67). Since the effect of boron management was non-significant, these differences were statistically comparable.

The interaction between plant growth regulators and boron management was significant as per the provided table. The lowest numerical sex ratio was recorded in P₄M₂- Ethrel @ 200 ppm + Boron @ 0.2% (3.37) followed by P₄M₁ (3.40) and P₄M₀ (3.45). The highest sex ratio was recorded in P₃M₀- Ethrel @ 100 ppm + Control (3.98), followed by P₃M₁ (3.93) and P₁M₂ (3.93).

The reduction in sex ratio under Ethrel @ 200 ppm was associated with the greater production of female flowers observed under this

treatment. Thus, the lower sex ratio indicates a comparatively favourable shift in sex expression towards female flowering, which is desirable in bottle gourd because female flowers ultimately contribute to fruit production. The present findings are supported by Sabu *et al.* (2022) [1], who reported that Ethrel @ 200 ppm was effective in mod-

ifying flowering behaviour, including the number of male and female flowers and sex ratio in bottle gourd. This finding are also agreement with Rahman *et al.* (2020) [10], who reported that plant growth regulators and trace elements influenced sex expression and flowering behaviour in bottle gourd.

Table 1. Effect of foliar application of plant growth regulators and boron on growth parameter in bottle gourd

Treatment	Vine length (m)	Node at first male flower	Node at first female flower	Day to first appear of male flower	Day to first appear of female flower	No. of male flower / Plant	No. of female flower/plant	Sex ratio
Factor (A)								
P ₀	4.46	12.32	15.03	53.06	58.13	49.78	13.53	3.68
P ₁	4.34	11.56	13.80	52.47	57.12	56.74	14.85	3.82
P ₂	5.37	9.42	12.47	45.13	53.42	71.72	20.42	3.52
P ₃	4.67	10.62	12.89	47.99	55.10	65.76	16.87	3.90
P ₄	6.25	8.79	11.87	42.66	47.80	73.01	21.43	3.41
SE(m±) (P)	0.11	0.11	0.26	1.04	0.81	1.16	0.33	0.03
C.D. (5%) (P)	0.32	0.33	0.77	3.03	2.38	3.39	0.96	0.09
Factor (B)								
M ₀	4.70	4.70	13.64	48.91	54.85	61.75	16.96	3.65
M ₁	5.20	5.20	13.17	48.28	54.40	63.35	17.39	3.67
M ₂	5.16	5.16	12.83	47.60	53.69	65.10	17.90	3.67
SE(m±) (M)	0.08	0.08	0.20	0.80	0.63	0.90	0.25	0.02
C.D. (5%) (M)	0.25	0.25	0.60	NS	NS	2.62	0.74	0.07
Interaction								
P ₀ M ₀	3.80	3.80	16.10	53.35	58.49	45.02	12.93	3.29
P ₀ M ₁	5.50	5.50	14.70	53.06	58.11	50.32	13.43	3.18
P ₀ M ₂	4.10	4.10	14.30	52.78	57.79	54.02	14.23	3.38
P ₁ M ₀	4.26	4.26	14.10	52.61	57.38	55.49	14.73	3.43
P ₁ M ₁	4.36	4.36	13.90	52.48	57.17	56.02	14.87	3.43
P ₁ M ₂	4.40	4.40	13.40	52.33	56.83	58.72	14.95	3.59
P ₂ M ₀	5.16	5.16	12.57	45.93	53.94	71.50	19.96	4.21
P ₂ M ₁	5.47	5.47	12.48	45.73	53.74	71.75	20.52	4.13
P ₂ M ₂	5.50	5.50	12.36	43.73	52.60	71.93	20.78	4.09
P ₃ M ₀	4.50	4.50	13.20	49.13	55.74	63.94	16.07	3.91
P ₃ M ₁	4.53	4.53	12.80	47.73	54.94	65.74	16.72	3.92
P ₃ M ₂	5.00	5.00	12.70	47.13	54.62	67.62	17.84	3.99
P ₄ M ₀	5.79	5.79	12.23	43.53	48.73	72.84	21.12	4.11
P ₄ M ₁	6.17	6.17	12.00	42.43	48.04	72.96	21.44	4.00
P ₄ M ₂	6.80	6.80	11.40	42.03	46.64	73.25	21.73	3.94
SE(m±) (P _X M)	0.19	0.19	0.46	1.80	1.417	2.01	0.57	0.05
C.D. (5%) (P _X M)	0.56	0.56	NS	NS	NS	NS	NS	0.22

Conclusion

The present investigation revealed that foliar application of plant growth regulators and boron significantly influenced growth, flowering, sex expression and yield of bottle gourd. Among the PGR treatments, Ethrel @ 200 ppm (P₄) was found most effective, while boron @ 0.2% (M₂) showed a favorable response. The combined application of Ethrel @ 200 ppm + boron @ 0.2% (P₄M₂/T₁₅) performed best, recording superior vine growth, earlier female flowering, higher female flower production and favourable sex ratio.

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