Original Research Article

Influence of different plant growth regulators and Boron on growth, yield and Sex Expression of BottleGourd (*Lagenaria siceraria* Mol.) under Garhwal Valley

ABSTRACT

The presentinvestigation was carriedout at Horticultural Research Centre, Department of Horticulture, H.N.B. Garhwal University,Uttarakhand, India during summer season, 2018-19. The existing experiment waslaid out in randomized block design following 13 treatments replicated thrice. The various growth parameters as well as yield attributes and yield were recorded during the experimentation. The result of the present investigationshowed that GA_3@ 50 mg/kgwas registered as the best treatment in terms of vine length (376.13 cm),fruits per vine (6.60), sex ratio (F:M) 1:11.07 and yield per vine (1357.33 g) and NAA @200 mg/kg+ Boron @ 0.1% with relation to the number of main branches per vine(10.87), length of fruit (24.57cm),diameteroffruit(90.10mm),yieldperplot(10.29kg/plot)andyieldperhectare(457.33 q)in bottle gourd. However, GA_3@ 50 mg/kg+ Boron @ 0.1% number of node per vine (24.27),number of node bearing first flower $GA_3$50 @ mg/kg(4.20) and NAA @ 150 mg/kg(4.20), weight offruit NAA @ 100 mg/kg+ Boron @ 0.1% (838.0 g) , total soluble solid GA_3@ 30 mg/kg(5.04 ºBrix)and NAA @ 200 mg/kgascorbic acid (12.90 mg/100g). The cultivar (Pusa Naveen) gives better response with the application of GA_3@ 50 mg/kgfor sex expression and NAA @ 200 mg/kg+ Boron @0.1% for various growth and yield parameters. It can be recommended toenhancetheproductionofbottle gourdunderGarhwalvalley of Uttarakhand.

Keywords: Bottle gourd, Boron, PGR, Sex expression, vine length and Yield

INTRODUCTION

Since ancient time fresh and edible portions of herbaceous plants are generally called vegetables, which are an important component of a healthy diet (Asaduzzaman and Asao, 2018). One of the most diverse families of vegetable species, cucurbits include a wide variety of crops that provide humans with both culinary properties and useful fibres.The bottle gourd, one of the many varieties of cucurbits, is a significant seasonal vegetable. It is frequently grown throughout the nation and is also referred to as lauki, ghia, kaddu, doodhi, ghaikaddu, etc. Fruits at their green, fragile state are utilised as vegetables and to make pickles, rayata, and other sweets. They also contain vitamin B and C, as well as a significant amount of calcium, iron, and phosphorus. After intake, it prevents constipation and has a cooling effect. A variety of factors, including the environment, nutrition, cultural practises, application of plant growth regulators (PGR), varietal features, and availability of staking, have an impact on the economic value of the bottle gourd during production. Mainly plant species and cultural condition embrace the limit of economical potential for plant growth regulators. To enhance the economic value of crop usage of plant growth regulators in vegetable to improve germination, crop uniformity, ease of harvesting and storage. The micronutrient boron (B) also creates an impact on the bottle gourd because it helps in the developmentand growth. Many PGR is effective in the sex expression of bottle gourd along with other cucurbits (Ansari and Chowdhary, 2022). The adequate use of plant growth regulators plays a significant role in sex expression and sex ratio; they are modified by environment, lowfertility of soil, higher temperature and longer light period which induce maleness. In suchcases, PGRs *viz*. NAA, GA_3, MH and micronutrient (B) were found to be effective. GA_3 enhances more cell division, cell wall elongation, cell wall plasticity and permeability of cell membranes, induced parthenocarpy and modify yield contributing characters of plant (Deepanshu and Singh, 2017). Keeping these considerations in mind, this experiment was planned to investigate the influence of boron and PGR on sex modification, growth, and yield of bottle gourd.

MATERIALS AND METHODS

During the summer season of 2018-19, the current field experiment was carried out at the Horticultural Research Centre, Chauras Campus, Department of Horticulture, H. N. B. Garhwal University, Srinagar (Garhwal), Uttarakhand (India). The Horticulture Research Centre, Srinagar, Garhwal is located on the northern side of the Alaknanda valley, between $78^{o}47' 30''$ E longitude, $30^{o}13' 0''$ N latitude, and 563 m msl, in the lower Himalayan region.

The experiment includes 13 various treatments consisting of differentplant growth regulators, boron and their combinations *viz.*, NAA, GA_3, MH, Boron andtheir combinations It was set up in a randomised block design with three replications using cv. Pusa Naveen obtained from IARI, New Delhi.

The use of various plant growth regulators, boron and their combinations were used at 2-true leaf stage. The whole plants were fully moistened with the solution. During the observation 5erratically selected plants were taken from each treatment per replications. The annotations were documented on the various parameters of growth, yield and quality. The quality parameters analysis was done according to the protocol provided by Rangnna, (2015).

The observation was obtained from the vegetative, yield and quality parameters. For recording the vegetative parameters vine length (cm), prime branches/ vine, nodes/ vine and nodes bearing flower early were recorded.Sex ratio (F:M), fruit/ vine, fruit weight (g), fruit length (cm), fruit diameter (mm), vineyield (g), yield/plot (kg) and yield per hectare (q) were measured for the yield parameters. While, for quality parameters total soluble solid (^{o}Brix) and ascorbic acid (mg/100g) were taken for the study.

The statistical analysis designed foreach and characters analyzed was conducted using the method proposed by Panse and Sukhatme (1961) for randomized block design and statistical analysis of data. The CD (Critical Difference) at 5% level of significance for each and every parameter was done.

RESULT AND DISCUSSION

The exogenous uses of different crop growth regulators at 2 leaf stages significantly affected the vegetative characters of bottle gourd as shown in table 1.

The highest vine length was registered with the use of GA_3 @ 50 ppm, which was found significantly superior over the rest of the treatments, whereas the minimum was obtained in MH @ 150 ppm. The increment in vine length may be due to the increase in the plasticity of the cell wall, to the hydrolysis of starch to sugars, with consequent entry of water into the cell, which causes elongation and rapid cell division, in which auxin production, protein synthesis, cellular elongation and expansion of bottle gourd vine.

Asrey*et al*. (2001) discovered a similar result in muskmelon, and Mia *et al*. (2014) discovered a similar result in bitter gourd. The largest number of primary branches per vine was observed when NAA at 200 mg/kgwas coupled with Boron at 0.1%. The minimum, on the other hand, was measured in MH @ 150 ppm. The combined action of NAA and boron increased the number of primary branches per vine, which might be attributed to increased cell division in the cambium, higher photosynthetic activity, and quicker horizontal growth, resulting in the greatest number of lateral shoots.These findings corroborate those published by Das and Das (1996) for pumpkin, Kiranmayi (2014) for chilli, and Ansari and Choudhary (2022) for bottle gourd. The combined usage of GA3 at 50 mg/kg+ Boron @ 0.1% resulted in the most nodes per vine, while NAA @ 200 mg/kgand control resulted in the fewest. GA3 increases the number of nodes, which may be attributed to its activity in protein synthesis, shoot apex, auxin production, cell division, bottle gourd vine expansion and lengthening. Ansari and Chowdhary (2022) obtained a similar result with bottle gourd.GA3 at 50 mg/kgand NAA at 150 mg/kghad the lowest number of nodes appearing initial flower. The highest, on the other hand, was obtained with a combination of MH at 150 mg/kg+ Boron @ 0.1%. The role of hormone movement, cell division, respiration, and water metabolism in accelerating blooming could be one of the reasons for the early appearance of the first flower. Hossain *et al*. (2006) made a similar observation with bitter gourd.

Thelowermostsex ratiowas obtained with the use of GA_3@ 50 ppm,whereas the highestwasnoticed in control. The sex ratio may be highly affected by genetics besides environmentfactors (*e.g.* photoperiod, temperature *etc*.). Change from vegetative growth to generativestages is a complex process regulated by many factors and can be influenced by the use of crop growth regulators. Growth regulators can change the sex ratio and sequence if applied at the 2 or 4 leaf stage, which is the important stage for suppressing or promoting either sex. Dixit *et al*. (2001) reported comparable results in watermelon, Dostogir*et al*. (2006) in bitter gourd, and Ujjwal *et al*. (2018) in tomato. The highest number of fruits per vine was reported in GA3 @ 50 ppm, whereas the lowest was observed in control. Poor pollination, percentage of fruit set, sex ratio, genetic nature, and reaction to varied climatic conditions could all explain the fluctuation in the quantity of fruits per vine.Sure *et al*. (2012) found a similar result in pumpkin, Dixit *et al*. (2001) in watermelon, Dostogir*et al*. (2006) in bitter gourd, Hidayatullah *et al*. (2012) in bottle gourd, and Ujjwal *et al*. (2018) in tomato. The combined application of NAA @ 100 mg/kg+ Boron @ 0.1% produced the most fruit weight, whereas the control produced the least. The combined application of NAA and boron can increase fruit weight due to increased nutrient availability, high nutrient uptake, and photosynthetic rate, all of which boost the fruit output of bottle gourd. Khatoon *et al*. (2019) and Fozia *et al*. (2018) discovered comparable results in bitter gourd.The longest fruit was found in NAA @ 200 mg/kg+ Boron @ 0.1%, which was shown to be significantly superior to the other treatments. The shortest fruit length was discovered in MH at 150 ppm.NAA may be responsible for increasing the activity of enzymes and sugars, resulting in increased fruit length. These findings agree with those of Rafeekher*et al*. (2002) in cucumber and Prabhu and Natarajan (2006) in ivy gourd. The maximum diameter of fruit was measured when NAA at 200 mg/kgwas combined with Boron at 0.1%. The lowest diameter of fruit, on the other hand, was discovered in the control.This could be due to increased cell wall permeability, hormonal activity, and photosynthetic activity, all of which contribute to increased fruit diameter. This study supported the findings of Rafeekher*et al*. (2002) in cucumber and Fozia *et al*. (2018) in bitter gourd. The greatest yield per vine was found to be non-significant in GA3 @ 50 ppm, however the minimal fruit production per vine was seen in the combination of GA3 @ 30 mg/kg+ Boron @ 0.1%. In comparison to the control for fruit output per vine, there is no significant response to any plant growth regulator or boron. The combination of NAA @ 200 mg/kg+ Boron @ 0.1% produced the highest yield per plot, while the control produced the lowest yield.The increase in yield is related to improved fruit production, improved uptake of hormones and water from the soil, and increased photosynthetic activity due to increased leaf number, which resulted in increased food accumulation per plant. These findings are consistent with those reported in bitter gourd by Marbhal*et al*. (2005) and Fozia *et al*. (2018). The combination of NAA @ 200 mg/kg+ Boron @ 0.1% produced the highest yield per hectare, while the control produced the lowest yield per hectare. The increase in yield-related features might be attributed to increased soil nutrient and water intake, increased leaf number and area, and increased photosynthetic activity and food buildup.These findings are consistent with those reported in bitter gourd by Marbhal*et al*. (2005) and Fozia *et al*. (2018).

The highest total soluble solid was identified in GA3 at 30 ppm, while the lowest was found in NAA at 100 ppm. This could be due to genetic factors and growth regulators, both of which influence the percentage of total soluble solids in the fruits. Furthermore, it could be owing to the fruit accumulating more reserve components. Shafeek *et al*. (2016) discovered a similar outcome in summer squash. The maximal ascorbic acid level of fruit was determined to be non-significant at 200 mg/kgin NAA.In contrast, the combination of NAA at 100 mg/kg+ Boron @ 0.1% resulted in the lowest ascorbic acid content of fruit.

Based on the findings of this study, it is possible to conclude that GA3 @ 50 mg/kgproduced the best results for lowest sex ratio and that the combination of NAA @ 200 mg/kg+ Boron @ 0.1% produced the best results for yield in bottle gourd. As a result, these treatments should be employed to boost bottle gourd output in the Garhwal region.

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Table1: Mean performances of bottle gourd *Cv*. Pusa Naveen with the impact of PGRs, boron and their combinations in case of length of vine (cm), primary branches per vine, nodes per vine and node bearing first flower

Treatments	Length of vine (cm)	Primarybranches per vine	Nodesper vine	Nodebearing first flower
Control	262.67	8.47	9.27	4.47
GA_3 @ 30 (mg/kg)	339.2	8.80	21.8	4.33
GA_3 @ 50 (mg/kg)	376.13	8.73	23.93	4.20
NAA @ 100 (mg/kg)	320.33	9.20	21.67	4.53
NAA @ 150 (mg/kg)	336.73	10.13	23.47	4.20
NAA @ 200 (mg/kg)	274.47	10.40	19.27	4.53
MH @ 150 (mg/kg)	254.13	7.80	19.40	4.73
Boron @ 0.1%	275.33	9.20	21.27	4.27
GA_3 @ 30 (mg/kg) + Boron @ 0.1%	351.93	10.40	23.47	4.47
GA_3 @ 50 (mg/kg) + Boron @ 0.1%	370.8	10.67	24.27	4.93
NAA @ 100 (mg/kg) + Boron @ 0.1%	303.87	10.07	20.73	4.93
NAA @ 200 (mg/kg) + Boron @ 0.1%	323.93	10.87	22.73	4.47
MH @ 150 (mg/kg) + Boron @ 0.1%	337.93	9.53	23.40	5.0
SEm (±)	79.46	0.18	0.52	0.18
CD (p= 0.05)	56.79	0.51	1.52	0.53

Table 2: Mean performances of bottle gourd *Cv*. Pusa Naveen with the impact of PGRs, boron and their combinations for sex ratio (F:M), fruits per vine, weight of fruit (g) and length of fruit (cm)

Treatments	Sex ratio (F:M)	Fruits per vine	Weight of fruit (g)	Length of fruit (cm)	Diameter of fruit (mm)	Yield perhectare(q)
Control	1:15.59	5.67	648.67	23.10	56.40	270.66
GA3 @ 30 (mg/kg)	1:11.69	6.53	584.0	22.97	56.80	366.66
GA3 @ 50 (mg/kg)	1:11.07	6.60	810.67	23.48	62.30	425.33
NAA @ 100 (mg/kg)	1:14.86	6.37	674.67	24.36	61.10	302.66
NAA @ 150 (mg/kg)	1:13.38	6.43	792.0	23.13	65.2	424.44
NAA @ 200 (mg/kg)	1:13.49	6.53	787.33	22.53	68.90	399.55
MH @ 150 (mg/kg)	1:12.46	6.23	730.0	22.01	67.10	438.66
Boron @ 0.1%	1:13.14	6.47	586.0	22.96	84.10	345.33
GA_3 @ 30 (mg/kg) + Boron @ 0.1%	1:12.09	6.07	676.66	22.59	70.0	346.22
GA_3 @ 50 (mg/kg) + Boron @ 0.1%	1:13.78	6.20	678.66	23.15	78.50	351.11
NAA @ 100 (mg/kg) + Boron @ 0.1%	1:12.14	6.47	838.0	23.25	74.10	342.66
NAA @ 200 (mg/kg) + Boron @ 0.1%	1:12.20	6.33	660.67	24.57	90.10	457.33
MH @ 150 (mg/kg) + Boron @ 0.1%	1:12.36	6.40	811.33	23.89	71.40	392.00
SEm (±)	0.80	0.17	57.55	0.51	5.64	57.22
CD (p= 0.05)	2.34	0.49	167.98	1.48	16.64	22.05

Table 3: Meanperformancesofbottlegourd*Cv*.PusaNaveenonimpactofPGRs,boronand theircombinationsforTSS(^{o}Brix)and ascorbicacid(mg/100g)

Treatments	TSS (^{o}Brix)	Ascorbic acid in(mg/100g)
Control	4.15	11.40
GA3@30(mg/kg)	5.04	12.77
GA3@50(mg/kg)	4.59	12.53
NAA @100(mg/kg)	3.85	12.23
NAA @150(mg/kg)	4.85	12.43
NAA @200(mg/kg)	4.48	12.90
MH@150(mg/kg)	4.44	11.97
Boron@0.1%	4.70	12.63
GA3@30(mg/kg)+Boron@0.1%	4.48	12.33
GA3@50(mg/kg)+Boron@0.1%	4.52	12.00
NAA @100(mg/kg)+Boron@0.1%	4.70	11.30
NAA@200(mg/kg)+Boron@0.1%	4.00	11.90
MH@150(mg/kg)+Boron@0.1%	4.44	11.93
SEm(±)	0.20	0.42
CD (p= 0.05)	0.60	1.24