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Effect of Gibberellic Acid and Boron on Growth, Yield and Yield Attributory Traits in Strawberry (*Fragaria* x *ananassa* Duch.) under North Gangetic Plains

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ABSTRACT: A field experiment was carried out at Garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology Kanpur (U.P.) during two subsequent years *i.e.*, 2018-19 and 2019-20 to investigate the effect of gibberellic acid and boron on growth, yield and yield attributory traits in strawberry (*Fragaria × ananassa* Duch.). Four concentrations each of GA_3 (0, 50, 75, and 100ppm) and Boron (0, 0.10, 0.25, and 0.50%) along with their combinations were used in Factorial Completely Randomized Design, which were replicated thrice. In strawberry use of Gibberellic acid (GA_3) rushed early flowering along with the expanded duration of blossoming, harvesting by increasing the yield and quality boundaries. The utilization of boron helps in the movement of sugar and advances fruit bud formation. It was inferred that 75 ppm of GA_3 and 0.50% boron were applied individually as well as their combinations, maximized plant height (cm), number of leaves, plant spread (cm), number of runners per plant, fruit length (cm), fruit diameter (cm), fruit volume (cc), fruit weight per plant (g) and yield (q/ha). The interaction effect of gibberellic acid and boron was significant only on fruit weight and yield (q/ha).

Keywords: Strawberry, Gibberellic acid, Boron, Growth, Yield and Yield attributory traits.

INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch.) is a hybrid between two American dioecious octaploid spp. *Fragaria chiloensis* and *Fragaria virginiana*, which belong to the family Rosaceae, is one of the most delicious and refreshing soft fruits of the world, which can be cultivated in temperate, subtropical, and tropical climates, wherever irrigation facilities exist. Being a quick-growing fruit crop, it is also suitable for kitchen gardening. In addition to fresh consumption, it has a special demand by the fruit processing industries for the preparation of jam, icecream, syrups, confectioneries, *etc*. It was first developed in France during the seventeenth century. All cultivated strawberry varieties are octaploid (2n = 8x = 56) in nature. In the country, it is grown in a 1000ha area with a total production of 5000mt (NHB, 2018-19). Strawberry is one of the most attractive, delicious, rich sources of vitamins; minerals and antioxidants which make strawberry highly delicious as well as also highly remunerative fruit and gives high returns per unit area in the shortest possible time. Application of gibberellic acid (GA_3) in strawberries has tenedearly flowering, duration of flowering, harvesting and inducingthe yield and quality of fruits. Boron being a heavy non-metal micronutrient playsan important role in fruit production. It is absorbed by the plant in the form of boric acid (H_3BO_3) for translocation of sugar; reproduction of plants and germination of pollen grains boron is necessary. Boron promotes fruit formation, besides being related to carbohydrate transport as borate sugar complex through membranes. Erratic work has been done to boost the yield and quality of strawberries with the aid of growth regulators trace elements. Therefore, keeping in view, the importance of fruits and the enormous rate of GA_3 and boron an example was planned to infer concrete information on the effect of these chemicals in respect of vegetative growth, fruiting and yield of strawberries.

MATERIAL AND METHODS

The present investigation on the effect of gibberellic acid and boron on vegetative growth, yield and yield attributory traits in strawberry (*Fragaria × ananassa* Duch.)'' was carried out during two subsequent years *i.e.*, 2018-19 and 2019-20 in the Garden, Department of Fruit Science, C.S. Azad University of Agriculture and Technology, Kanpur (U.P.), which is located inthe alluvial belt of Gangetic plains of central Uttar Pradesh. For this an experiment was planned using 16 treatments *viz.*, using four concentrations each of GA_3 (0, 50, 75, and 100ppm) and Boron (0, 0.10, 0.25, and 0.50%) along with their combinations, replicated thrice in a Factorial Completely Randomized Design. One year old, healthy, uniform and disease-free runners of "Chandler" cultivar were procured from Dr. Y.S.

Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) and transplanted at 45×45cm spacing on October 20 during both years. Other cultural practices including irrigation, insectpests and disease management were common in all treatments. The observations were recorded from each treatment of all three replication. Five plants of strawberry were selected randomly and tagged under each treatment for recording different vegetative attributes *viz.*, plant height (cm), number of leaves per plant, plant spread (cm), number of runners per plant, yield (q/ha) and other yield attributory traits *viz.,* fruit size, fruit volume (cc), total fruit weight (g).

RESULTS AND DISCUSSION

All the plant growth parameters enhanced significantly with different doses of gibberellic acid and boronas observed at different crop growth stages *i.e.,* 30, 60 and 90 DAP.

The plant height was recorded significantly maximum at 30 (9.39 and 10.49 cm), 60 (18.00 and 19.04 cm) and 90 (27.16 and 28.22 cm) days after transplanting with the foliar application of 75 ppm GA_3 (Table 1). The plants under control expressed significantly minimum height at 30 (7.55 and 8.85 cm), 60 (14.31 and 15.52 cm) and 90 (21.85 and 22.90 cm) during respective years of study. Application of 75 ppm GA_3 recorded 24.37 and 18.53%, 25.78 and 22.68% and 24.30 and 23.23% increase in plant height at respective periodical stages as compared to control. This increase in plant height may be attributed to the increase in the cell elongation coursed by the application of GA_3 which increased the synthesis of auxin in the strawberry plant system. These findings are in accordance with the findings of Dubey *et al.,* (2017); Kumar and Tripathi (2009) in strawberry.

Boron treatments improved plant height to the maximum (9.16 and 10.38 cm at 30, 17.56 and 18.61 cm at 60 and 26.50 and 27.56 cm at 90 DAP) when 0.50% boron was sprayed. The minimum plant height was 8.12 and 9.32 cm, 15.40 and 16.60 cm and 23.50 and 24.52 cm at corresponding stages with 0.50% boron. However, it improved the height by 12.80 and 11.37%, 14.20 and 12.11% and 12.76 and 12.40% over control. The increase in growth due to the application of boron could be ascribed to its role in nitrogen metabolism, phytohormones regulation and active cell proliferation.G_2B_3 interaction maximizing plant height showed 10.13 and 11.21cm, 19.41 and 20.49 cm and 29.30 and 30.36 cm values at corresponding stages.

The number of leaves increased gradually with advancing age and the maximum number of leaves per plant (4.69 and 5.75), (17.63 and 18.69) and (25.78 and 27.02) were recorded under 75 ppm of GA_3 treatment against the minimum of 3.77 and 4.76, 14.18 and 15.22 and 20.74 and 22.77 leaves observed under control at periodical stages of observation. A final observation *i.e.,* 90 DAP the leaf number ranged from 20.74 to 25.78 and 22.77 to 27.02 due to GA_3 treatment causing 24.30 and 18.66% improvement over control during respective years of trial. Improvement in foliage in terms of leaf number is owing to the optimum concentration of GA_3 which is helped in strawberry plants which might have in cell division and cell enlargement. The present results are in conformity with the reports of Tripathi and Shukla (2006); Qureshi *et al*. (2013) in strawberry.

Boron consistently and positively affected the production of leaves and its highest concentration 0.50% maximized it expressing 4.58 and 5.63, 17.20 and 18.26 and 25.15 and 26.62 leaves at 30, 60 and 90 DAP respectively during both years of study. The minimum numbers of leaves 4.06 and 5.09, 15.25 and 16.28 and 22.30 and 24.04 were observed under control at respective stages. Application of 0.50% boron caused 12.80 and 10.60%, 12.78 and 12.16% and 12.78 and 10.65% increase in this regard at respective DAP and year of stages as compared to control. The improvement coursed by boron may be attributed to its role in water relation in the cells which promotes translocation of major as well as, micronutrients and ultimately enhance leaf production. These findings of the present investigators are in accordance with the reports of Tiwari *et al.,* (2017); Kumar *et al.,* (2017) in aonla. The interactive effect between GA_3 and boron numerically improved leaf number in all the stages of growth. However, G_2B_3 treatment proved the most effective.

Plant spread was significantly influenced by different doses of gibberellic acid and boron at all the periodical observations. Foliar spray of 75 ppm GA_3 significantly maximized it at 30 (5.98 and 7.04 cm), 60 (15.93 and 17.35 cm) and 90 (23.11 and 24.38 cm) days after transplanting and the plants under control expressed significantly poorest plant spread 4.85 and 5.94 cm, 12.81 and 14.16 cm and 18.59 and 19.87 cm at respective stages of plant growth. Application of 75 ppm GA_3 recorded 23.30 and 18.52%, 24.36 and 22.53% and 24.31 and 22.70% at the periodical observations as compared to control during corresponding. The improvement in both the growth parameters might be due to fact that gibberellins regulate the growth of plants by causing cell elongation in the plant system Tripathi and Shukla (2007); working with strawberry noted similar results.

The plant spread was significantly maximum (5.84 and 6.90, 15.54 and 16.92 and 22.55 and 23.81 cm) with the treatment of 0.50% boron against the lowest values recorded under control showing poor 5.19 and 6.28, 13.78 and 15.15 and 19.99 and 21.27 cm at respective stages. However, 12.52 and 9.87%; 12.77 and 11.68% and 12.80 and 11.94% increase was noted over control. The beneficial effect of boron with the present trial may be accessible to its optimum level which might have influenced the supply of carbohydrates to the meristematic tissues which in turn increase vegetative growth of plants. Apart from this, Boron playing a significant role in the metabolism of nitrogen, hormone movement and cell division improved vegetative growth. The findings are in agreement with the reports of Paray *et al.,* (2021).

Table 1: Effect of gibberellic acid, boron and their interactions on plant height, number of leaves, plant spread and numbers of runners per plant.

Treatments	Plant height (cm)						Number of leaves per plant						Plant spread (cm)						No. of runners per plant	
	30		60		90		30		60		90		30		60		90			
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
G_0	7.55	8.85	14.31	15.52	21.85	22.9	3.77	4.76	14.18	15.22	20.74	22.77	4.85	5.94	12.81	14.16	18.59	19.87	5.29	6.53
G_1	8.55	9.85	16.4	17.45	24.75	25.8	4.28	5.33	16.07	17.12	23.49	25.51	5.45	6.5	14.51	15.83	21.06	22.34	5.99	7.23
G_2	9.39	10.49	18	19.04	27.16	28.22	4.69	5.74	17.63	18.69	25.78	27.02	5.98	7.04	15.93	17.35	23.11	24.38	6.57	7.83
G_3	9.26	10.31	17.75	18.81	26.79	27.83	4.63	5.69	17.39	18.43	25.43	26.49	5.9	6.94	15.71	17.24	22.8	24.08	6.48	7.76
Esm±	**0.12**	**0.12**	**0.3**	**0.25**	**0.37**	**0.37**	**0.12**	**0.12**	**0.25**	**0.32**	**0.37**	**0.44**	**0.13**	**0.19**	**0.25**	**0.29**	**0.25**	**0.3**	**0.12**	**0.18**
CD at 5%	**0.36**	**0.34**	**0.86**	**0.72**	**1.08**	**1.08**	**0.36**	**0.36**	**0.72**	**0.93**	**1.08**	**1.29**	**0.37**	**0.39**	**0.72**	**0.84**	**0.72**	**0.88**	**0.36**	**0.52**
B_0	8.12	9.32	15.4	16.6	23.5	24.52	4.06	5.09	15.25	16.28	22.3	24.04	5.19	6.28	13.78	15.15	19.99	21.27	5.68	6.94
B_1	8.6	9.76	16.48	17.54	24.88	25.93	4.3	5.35	16.15	17.19	23.61	25.12	5.48	6.53	14.59	16.06	21.16	22.44	6.02	7.27
B_2	8.88	10.04	17.02	18.07	25.69	26.73	4.44	5.46	16.67	17.71	24.38	26.01	5.66	6.7	15.06	16.45	21.85	23.14	6.21	7.47
B_3	9.16	10.38	17.56	18.61	26.5	27.56	4.58	5.63	17.2	18.26	25.15	26.62	5.84	6.9	15.54	16.92	22.55	23.81	6.41	7.68
Esm±	**0.12**	**0.12**	**0.3**	**0.25**	**0.37**	**0.37**	**0.12**	**0.12**	**0.25**	**0.32**	**0.37**	**0.44**	**0.13**	**0.19**	**0.25**	**0.29**	**0.25**	**0.3**	**0.12**	**0.18**
CD at 5%	**0.36**	**0.34**	**0.86**	**0.72**	**1.08**	**1.08**	**0.36**	**0.36**	**0.72**	**0.93**	**1.08**	**1.29**	**0.37**	**0.39**	**0.72**	**0.84**	**0.72**	**0.88**	**0.36**	**0.52**
G_0B_0	7.17	8.36	13.08	14.76	20.75	21.76	3.58	4.49	13.47	14.51	19.69	21.66	4.64	5.91	12.16	13.51	17.65	18.92	5.02	6.26
G_0B_1	7.48	8.73	14.33	15.38	21.63	22.7	3.74	4.78	14.04	15.06	20.53	22.62	4.77	5.84	12.68	14.03	18.4	19.68	5.23	6.48
G_0B_2	7.68	8.95	14.72	15.79	22.22	23.27	3.84	4.86	14.42	15.41	21.09	23.14	4.9	5.95	13.03	14.36	18.91	20.16	5.38	6.6
G_0B_3	7.88	9.36	15.11	16.14	22.81	23.87	3.94	4.93	14.81	15.89	21.65	23.65	5.03	6.09	13.38	14.75	19.41	20.71	5.52	6.79
G_1B_0	8.12	9.38	15.57	16.58	23.5	24.55	4.06	5.14	15.25	16.31	22.3	24.46	5.18	6.23	13.78	15.14	19.99	21.28	5.68	6.94
G_1B_1	8.5	9.82	16.29	17.36	24.58	25.61	4.25	5.31	15.95	17	23.33	25.43	5.42	6.45	14.41	15.7	20.91	22.17	5.95	7.17
G_1B_2	8.7	10	16.68	17.73	25.17	26.18	4.35	5.4	16.34	17.37	23.89	26.01	5.55	6.56	14.76	16.08	21.42	22.71	6.09	7.35
G_1B_3	8.9	10.21	17.07	18.13	25.76	26.84	4.45	5.48	16.72	17.81	24.45	26.15	5.68	6.76	15.11	16.41	21.92	23.19	6.23	7.46
G_2B_0	8.39	9.69	16.09	17.14	24.29	25.33	4.2	5.29	15.76	16.8	23.05	24.81	5.35	6.39	14.24	15.55	20.66	21.94	5.87	7.12
G_2B_1	9.41	10.44	18.05	19.08	27.24	28.31	4.71	5.71	17.68	18.75	25.85	26.65	6	7.07	15.97	17.41	23.17	24.44	6.59	7.83
G_2B_2	9.62	10.63	18.44	19.45	27.83	28.88	4.81	5.8	18.06	19.11	26.41	27.73	6.13	7.18	16.32	17.8	23.67	24.99	6.73	8.02
G_2B_3	10.13	11.21	19.41	20.49	29.3	30.36	5.06	6.14	19.02	20.08	27.81	28.89	6.46	7.52	17.18	18.64	24.93	26.17	7.08	8.35
G_3B_0	8.8	9.84	16.87	17.91	25.47	26.46	4.4	5.46	16.53	17.52	24.17	25.23	5.61	6.6	14.93	16.39	21.62	22.96	6.16	7.43
G_3B_1	9.01	10.08	17.26	18.33	26.06	27.11	4.5	5.55	16.91	17.96	24.73	25.78	5.74	6.79	15.28	17.09	22.17	23.48	6.3	7.59
G_3B_2	9.52	10.57	18.24	19.29	27.53	28.6	4.76	5.79	17.87	18.94	26.13	27.16	6.07	7.14	16.14	17.58	23.42	24.7	6.66	7.9
G_3B_3	9.72	10.75	18.63	19.69	28.12	29.15	4.86	5.95	18.25	19.28	26.69	27.78	6.2	7.23	16.49	17.89	23.93	25.17	6.8	8.11
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Sem±	**0.25**	**0.24**	**0.6**	**0.5**	**0.75**	**0.75**	**0.25**	**0.25**	**0.5**	**0.64**	**0.75**	**0.89**	**0.26**	**0.27**	**0.5**	**0.58**	**0.5**	**0.61**	**0.25**	**0.36**

Table 2: Effect of gibberellic acid, boron and their interactions on fruit length (cm), fruit diameter (cm), fruit volume (cc), fruit weight per plant (g) and yield (q/ha).

Treatments	Fruit length (cm)		Fruit diameter (cm)		Fruit volume (cc)		Fruit weight per plant (g)		Yield q/ha	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
G_0	3.33	3.93	2.65	3.10	14.03	14.37	162.51	163.52	80.24	80.75
G_1	3.78	4.37	3.00	3.45	15.90	16.24	210.34	211.36	103.87	104.37
G_2	4.15	4.76	3.29	3.75	17.44	17.80	239.76	240.79	118.39	118.91
G_3	4.09	4.69	3.25	3.71	17.21	17.55	238.32	239.34	117.68	117.69
Esm±	**0.05**	**0.09**	**0.04**	**0.04**	**0.28**	**0.25**	**1.49**	**1.49**	**1.350**	**1.38**
CD at 5%	**0.16**	**0.28**	**0.12**	**0.11**	**0.83**	**0.72**	**4.31**	**4.30**	**3.899**	**4.00**
B_0	3.59	4.19	2.85	3.31	15.09	15.44	184.72	185.74	91.21	90.97
B_1	3.80	4.40	3.01	3.47	15.98	16.32	212.25	213.26	104.81	105.31
B_2	3.92	4.52	3.11	3.57	16.50	16.84	215.36	216.38	106.34	106.85
B_3	4.04	4.64	3.21	3.66	17.02	17.36	238.60	239.62	117.82	118.58
Esm±	**0.05**	**0.09**	**0.04**	**0.04**	**0.28**	**0.25**	**1.49**	**1.49**	**1.35**	**1.38**
CD at 5%	**0.16**	**0.28**	**0.12**	**0.11**	**0.83**	**0.72**	**4.31**	**4.30**	**3.89**	**4.00**
G_0B_0	3.16	3.75	2.51	2.96	13.33	13.66	121.96	122.97	60.22	60.72
G_0B_1	3.30	3.90	2.62	3.07	13.89	14.23	174.13	175.14	85.92	86.49
G_0B_2	3.39	3.96	2.69	3.12	14.27	14.59	175.62	176.61	86.72	87.21
G_0B_3	3.48	4.11	2.76	3.24	14.65	15.02	178.33	179.37	88.06	88.57
G_1B_0	3.59	4.20	2.85	3.31	15.09	15.45	197.48	198.50	97.51	98.02
G_1B_1	3.75	4.33	2.98	3.41	15.79	16.11	208.00	209.00	102.71	103.20
G_1B_2	3.84	4.45	3.05	3.52	16.17	16.52	209.30	210.33	103.35	103.87
G_1B_3	3.93	4.52	3.12	3.56	16.55	16.88	226.60	227.60	111.89	112.39
G_2B_0	3.71	4.30	2.94	3.39	15.60	15.94	199.52	200.53	98.52	99.03
G_2B_1	4.16	4.75	3.33	3.75	17.49	17.83	233.74	234.75	115.42	115.92
G_2B_2	4.25	4.89	3.37	3.86	17.87	18.25	238.92	239.98	117.98	118.51
G_2B_3	4.47	5.09	3.55	4.02	18.82	19.18	286.86	287.89	141.65	142.17
G_3B_0	3.89	4.51	3.09	3.56	16.36	16.72	219.93	220.96	108.60	106.12
G_3B_1	3.98	4.61	3.16	3.65	16.74	17.11	233.12	234.17	115.11	115.64
G_3B_2	4.20	4.80	3.34	3.79	17.68	18.02	237.60	238.61	117.33	117.83
G_3B_3	4.29	4.85	3.41	3.83	18.06	18.36	262.63	263.61	129.69	131.18
Sem±	**0.11**	**0.19**	**0.08**	**0.08**	**0.57**	**0.50**	**2.98**	**2.98**	**2.69**	**2.77**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**8.63**	**8.60**	**7.79**	**8.00**

The number of runners per plant was enhanced significantly with the foliar application of different doses of gibberellic acid and boron. GA_3 being the most effective maximized number of runners to the tune of 6.57 and 7.83 were plants treated with 75 ppm of GA_3. It was, however, the recorded minimum under control (5.29 and 6.53). Application of 75 ppm GA_3 caused a 24.19 and 19.91% increase in the production of runners as compared to control. GA_3 being effective is increased height, the number of leaves and leaf area might have facilitated the accumulation of more photosynthates leading to increased production of runners. Gibberellins are synthesized by young leaves and root tips improving the vegetative growth of the plants inducing the runners. The present findings are in close conformity with the results of Dubey *et al.,* (2017); Kumar and Tripathi (2009); Ali *et al.,* (2011) in strawberry.

Boron nutrition consistently improved the production of runners. The plants treated with 0.50% boron enhanced the number of the runner to the maximum 6.41 and 7.68 as compared to its other concentrations, whereas the minimum 5.68 and 6.94 were revealed by control. Application of 0.50% boron caused 12.85 and 10.66% improvement in the production of runners as compared to control. The results are in accordance with Meena, (2010) finding who observed an increase in vegetative growth of tomato who is of the opinion that boron has its and its involvement in the metabolism of protein, synthesis of pectin, maintaining the correct water relation within the plant, re-synthesis of adenosine triphosphate (ATP) and translocation of sugar. Singh and Tripathi (2010); Dubey *et al.,* (2017) also found similar results in strawberries.

YIELD AND YIELD ATTRIBUTORY TRAITS

The yield attributory traits *viz*., fruit length (cm), fruit diameter (cm) and fruit volume (cc), fruit weight per plant and yield q/ha of strawberry was significantly influenced by GA_3 treatment and its 75 ppm treatments proved most effective and maximized the fruit length (4.15, 4.76 cm), fruit diameter (3.29, 3.75 cm) and fruit volume (17.44, 17.80 cc) during respective years. GA_3 control exhibited the poorest values in all the parameters during both the years of experimentation Table 2. The increase in the above attributes recorded due to GA_3 75 ppm was recorded to the tune of 24.62, 21.11%, 24.15, 20.96% and 24.30, 23.86% over control respectively. The improvement in respect of the above is obviously due to a greater supply of nutrients and photosynthates to the berries. Similar results have been reported by Dubey *et al.,* (2017) in strawberry; Maurya *et al.,* (2020); Singh *et al.,* (2017) in mango and Bhadauria *et al.,* (2018) in aonla.

Boron also improved the growth attributes maximizing fruit length (4.04, 4.64 cm), fruit diameter (3.21, 3.66 cm) and fruit volume (17.02, 17.36 cc) at 0.50% concentration. The minimum values in this regard were noted as 3.59, 4.19, 2.85, 3.31 cm and 15.09, 15.44 cc respectively under control. The enhancement in the above traits was to the tune of 12.53, 10.74%; 12.63, 10.57 and 12.79, 12.43% over control respectively. Boron in the present study helped maximize growth attributes by accelerating the transportation of photosynthates from leaf to the developing fruits.

The improvement in size can thus be attributed to the greater mobilization of food materials from the site of their production to the storage organs under the influence of applied micronutrients. Since boron plays an important role in nitrogen metabolism and cell division and cell enlargement, thus it might have increased the fruit size.

The findings are in agreement with the reports of Tripathi and Shukla (2010) in strawberry; Shukla *et al.,* (2011); Tiwari *et al.,* (2017); Kumar *et al.,* (2017) in aonla. Interactive treatments of GA_3×boron did not bring significant variation in these attributes. However, G_2B_3 proved relatively superior.

The application of 75 ppm GA_3 brought aboutthe significantly highest fruit weight 239.76 and 240.79 g per plant and yield 118.39 and 118.91 q/ha whereas; untreated plants gave the minimum 162.51, 163.52 g fruit weight and 80.24, 80.75 q/ha yield during former and latter years of investigation. Improvement in yield was recorded 47.54, 47.27% over control. The improvement in yield parameters might be due to the fact that gibberellic acid causes the production of a larger number of flowers with rapid elongation of the peduncle, leading to the full development of flower buds having all reproductive parts functional which increases the fruit set and the number of berries. Apart from this GA application accelerates the development of differentiated inflorescence. Similar results have been reported by Singh and Tripathi (2010); Dubey *et al*., (2017) in strawberry; Singh *et al.,* (2017) in mango.

Increasing levels of boron increased both the attributes and application of 0.50% boron maximized fruits (238.60 & 239.62 g) and yield (117.82 & 118.58 q/ha) during 2018-19 and 19-20. Controls gave the minimum of 184.72 & 185.74 g fruits weight and 91.21 & 90.97 q/ha yield. The application of B produced 29.17, 29.00% and 29.17, 30.35% improvement in the above attributes over control. It may be owing to the application of boron which enhances pollen germination, pollen tube growth causing low fruit drop thereby increasing fruit set. The present findings are in accordance with the reports of Shukla *et al.,* (2011); Tiwari *et al.,* (2017); Kumar *et al.,* (2017) in aonla. The interaction of GA_3 & boron improved the yield further and G_2B_3 gave maximum fruit weight 286.86, 287.89 g and yield 141.65 and 142.17 q/ha in corresponding years of trial. G_0B_0 expressed significantly minimum values 121.96, 122.97 g and 60.22, 60.72 q/ha respectively during former and later years of study.

CONCLUSION

Based on the results obtained, it is concluded that individual application of both GA_3 at 75 ppm and boron 0.50 % significantly maximized vegetative growth, yield attributes and yield of strawberry. Application of GA_3 @ 75ppm associated with boron @ 0.50% significantly enhanced the yield (q/ha) in strawberry. The achievements of the present investigation are of paramount significance and possess great potential in improving the economy and prosperity of the country.

FUTURE SCOPE

Plant bio-regulators and micro-nutrients plays an important role in higher yield of quality fruit production. Since strawberry is now-a days, becoming an important fruit crop all over the world. That's why in future, by using different plant bio-regulators and micronutrients alone and in combinations further studies can be carried out.

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