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Studies on the Effect of Gibberellic Acid and Boron on Flowering, Fruiting and Yield of Strawberry (*Fragaria* x *ananassa* Duch.)

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A B S T R A C T

A field experiments was carried out at Horticulture Garden of the Department of Fruit Science, C. S. Azad University of Agriculture & Technology Kanpur (U.P.) during 2018-19 and 19-20. Four concentrations of GA_3 and Boron *viz.* 0, 50, 75 and 100 ppm GA_3 and 0, 0.10, 0.25 and 0.50% boron along with their combinations were tried in a Factorial Completely Randomized Design replicated thrice to find out their role on the flowering, fruiting and yield of strawberry. The results revealed that the application of 75 ppm of GA_3 and 0.50% boron hastened flowering, fruit setting and increased number of flowers and fruits per plant and yield (q/ha). The interaction proved significantly effective in boosting yield.

Introduction

Strawberry botanically *Fragaria* x *ananassa* Duch. is a hybrid between two American dioecious octaploid *spp*. *Frageria chiloensis* and *Fragaria virginiana*, belong to the family Rosaceae. All cultivated varieties of strawberry are octaploid in nature (2n = 8x = 56). It is an herbaceous perennial plant successfully cultivated in a wide range of agro-climatic conditions from subtropics to temperate climate (Singh and Tripathi 2010). It is highly remunerative crop and gives higher returns per unit area in the shortest possible time. Its fruits are in great demand for fresh market as well as in processing industry (jam, ice-cream, syrups, etc.). The plant is a surface feeder therefore fertility, moisture, drainage and microbial status of the upper layer of soil have great impact on growth, development, fruit yield, quality and production of runners (Rajbhar *et al.*, 2017). Erratic information is available on gibberellic acid (GA_3) in respect of flowering, fruiting and yield. Boron also boosts the flowering and fruiting of fruit crops but it has not been studied through systematic experimentation and the information is megre and unauthentic regarding attributes

flowering, yield and quality particularly in of strawberry (Sharma and Singh *et al.,* 2009). Boron play important role in increasing flowering, yield and quality of fruits (Lieten, 1998). Keeping in view the information of the crop and role of the above chemicals a systematic experiment entitled "Studies on the effect of gibberellic acid and boron on flowering, fruiting and yield of strawberry (*Fragaria* x *ananassa* Duch.)'' was planned with the chief objective of achieving concrete information on flowering, fruiting and yield of strawberry under the subtropical conditions prevailing under Central Uttar Pradesh.

Materials and Methods

One year old, healthy, uniform and disease free runners of "Chandler" cultivar were procured from Dr. Yashwant Singh Parmar University of Horticulture & Forestry Nauni, Solan (Himanchal Pradesh) and transplanted in 1.35×1.8m bed 45×45cm apart on 20 October 2018-19 and 19-20 at Horticulture Garden of C. S. Azad University of Agriculture and Technology Kanpur (U.P.). It was a field trial with 16 treatments, replicated thrice in a Factorial Completely Randomized Design. Aqueous solutions of GA_3 (0, 50, 75, 100 ppm) and boron (0, 0.10, 0.25 and 0.50%) were sprayed on the plants with a hand sprayer. Four concentrations each of GA_3 and Boron *viz.* 0, 50, 75 and 100 ppm GA_3 and 0, 0.10, 0.25 and 0.50% boron along with their combinations were sprayed on strawberry plants. Five plants were tagged randomly under each treatment for recording observations. On days to flowering, days to fruit setting, number of flowers and fruits per plant and yield (q/ha).

Results and Discussion

Application of GA_3 75 ppm in the present study expressed its efficacy in flower initiation and fruit setting into plants under control delaying flowering and fruiting required 68.22 & 69.58 days and 77.96 & 79.31 days respectively during first and second years of investigation respectively whereas, both the attributes were hastened by GA_3 treatments. The earliest flowering (54.71 & 56.09 days) and fruit setting (62.53 & 64.31 days) were observed under 75 ppm GA_3 treatment during former and latter years of study. Earliness in flowering and fruit setting was recorded by 19.80 & 19.38% and 19.79 & 18.91% over control due to 75 ppm sprays of GA_3.

The earliness thus may be ascribed to foliar spray of GA_3 which played significant role in hastened flowering and fruiting as well. The synthesis of florigen is mediated gibberellins which positively affect flowering and fruiting. These results are in agreement with the report of have got the support of the finding of Singh and Tripathi (2010) and Lopez *et al.,* (1989) in strawberry.

Foliar sprays of boron significantly influenced the flower emergence as well as fruit setting in strawberry. Spraying of boron doses in ascending order caused the period required for flowering and fruit setting in descending order. Untreated plants required maximum 62.23 & 63.59 days for flower initiation and 71.12 & 73.14 days for fruit setting during respective years of study.

The plants treated with 0.50% concentration of boron took minimum period for flower initiation (57.05 & 58.37 days) and fruit setting (65.15 & 66.50 days) during corresponding years of trial. It may be due to better growth of plants which could be attributed to physiological role of boron 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 at flower and fruit development stages (Meena, 2010) (Table 1).

Table.1 Effect of gibberellic acid, boron and their interactions on days to flowering, days to fruit setting, number of flowers per plant, number of fruits per plant and yield (q/ha) of strawberry

Treatments	Days to flowering		Days to fruit setting		Number of flowers per plant		Number of fruits per plant		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	68.22	69.58	77.96	79.31	23.38	24.53	17.05	18.06	80.24	80.75
G_1	61.40	62.76	70.17	71.52	24.75	25.90	19.47	20.47	103.87	104.37
G_2	54.71	56.09	62.53	64.56	25.84	27.08	21.43	22.44	118.39	118.91
G_3	55.13	56.45	62.96	64.31	25.34	26.58	21.15	22.16	117.68	117.69
Esm±	**0.25**	**0.36**	**0.26**	**0.35**	**0.21**	**0.40**	**0.25**	**0.29**	**1.350**	**1.38**
CD at 5%	**0.74**	**1.06**	**1.06**	**1.03**	**0.72**	**1.16**	**0.72**	**0.86**	**3.899**	**4.00**
B_0	62.23	63.59	71.12	73.14	23.78	25.10	18.37	19.38	91.21	90.97
B_1	60.91	62.28	69.61	70.97	24.55	25.70	19.62	20.63	104.81	105.31
B_2	59.27	60.64	67.74	69.10	25.13	26.29	20.18	21.20	106.34	106.85
B_3	57.05	58.37	65.15	66.50	25.84	26.99	20.91	21.92	117.82	118.58
Esm±	**0.25**	**0.36**	**0.24**	**0.35**	**0.21**	**0.40**	**0.25**	**0.29**	**1.35**	**1.38**
CD at 5%	**0.74**	**1.06**	**1.06**	**1.03**	**0.72**	**1.16**	**0.72**	**0.86**	**3.89**	**4.00**
G_0B_0	71.63	72.98	81.86	83.21	22.53	23.67	15.78	16.78	60.22	60.72
G_0B_1	69.16	70.52	79.03	80.38	23.23	24.38	17.03	18.04	85.92	86.49
G_0B_2	67.33	68.67	76.94	78.27	23.70	24.83	17.39	18.37	86.72	87.21
G_0B_3	64.76	66.14	74.01	75.39	24.05	25.23	18.03	19.06	88.06	88.57
G_1B_0	63.66	65.03	72.76	74.12	24.17	25.34	18.44	19.46	97.51	98.02
G_1B_1	62.53	63.87	71.45	72.78	24.52	25.65	19.43	20.42	102.71	103.20
G_1B_2	60.76	62.13	69.44	70.80	24.72	25.88	19.68	20.70	103.35	103.87
G_1B_3	58.66	60.01	67.05	68.39	25.58	26.72	20.31	21.31	111.89	112.39
G_2B_0	56.68	58.03	64.77	68.78	24.15	25.63	19.12	20.12	98.52	99.03
G_2B_1	56.32	57.58	64.26	65.60	25.70	26.84	21.47	22.47	115.42	115.92
G_2B_2	54.16	55.56	61.90	63.29	26.17	27.36	21.95	23.00	117.98	118.51
G_2B_3	51.80	53.17	59.19	60.56	27.34	28.51	23.17	24.20	141.65	142.17
G_3B_0	56.94	58.32	65.08	66.45	24.29	25.79	20.15	21.18	108.60	106.12
G_3B_1	55.75	57.14	63.71	65.10	24.76	25.94	20.56	21.60	115.11	115.64
G_3B_2	54.85	56.20	62.69	64.03	25.93	27.08	21.73	22.73	117.33	117.83
G_3B_3	52.98	54.14	60.36	61.68	26.40	27.52	22.15	23.12	129.69	131.18
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**2.69**	**2.77**
Sem±	**0.51**	**0.73**	**0.73**	**0.71**	**0.50**	**0.80**	**0.50**	0.59	**7.79**	**8.00**

The number of flowers and fruit set per plant were significantly enhanced by different doses of gibberellic acid and boron. The maximum number of flowers (25.84 & 27.08) and fruits set (21.43 & 22.44) per plant were recorded in GA_3 at 75 ppm treated plant during both years of investigation. The minimum of it 23.38 & 24.53 and 17.05 and 18.06 was found under control. Application of 75 ppm GA_3 caused 10.52, 10.39% and 25.68, 24.25% increase in the above attributes as compared to control. The superiority brought about by GA_3 treatment might be due to its, stimulation for conversion of stored polymers (polysaccharides, proteins and fats) into sucrose or mobile amino acids to facilitate their translocation via phloem into and throughout the young root and shoot system and thus influencing flower production. Results of present study are similar to that reported by Paroussi *et al.,* (2002) and Kappel and Donald (2007) in strawberry.

Boron nutrition proved significantly effective in increasing the number of flowers and fruit set with its increasing levels during both years of study. Boron its 0.50% spray produced maximum flowers and fruit set to the tune of 25.84 & 26.99 and 20.91 & 21.92 per plant respectively. However, the minimum number of flowers 23.78 & 25.10 and fruit set 18.37 & 19.38 were recorded under control during corresponding years. Improvement in the production of flowers and fruits set due to 0.50% boron were noted 8.66, 7.52% and 13.82, 13.10% in respective years. It may be attributed to foliar feeding of boron which regulates metabolism involved in translocation of carbohydrates, cell wall development and RNA synthesis. The findings of the present investigation are in agreement with the reports of Ram and Bose, (2000) in mandarin orange.

The application of 75 ppm GA_3 produced significantly highest fruit yield 118.39 & 118.91 q/ha against the minimum 80.24, 80.75 q/ha recorded under control. Improvement in fruit weight and fruit yield over control was recorded in 47.54, 47.27% respectively. The enhanced weight and yield with the application of GA_3 might be due to the fact that gibberellic acid causes the production of large number of flowers with rapid elongation of peduncle, leading to full development of flower buds having all reproductive parts functional which increases the fruit set and number of berries per plant. Apart from this GA application accelerates the development of differentiated inflorescence. Present results are in given with the reports of Kranthi and Sharma (2016) in grape. Singh and Tripathi (2010) in strawberry.

Boron treatment significantly improved the fruit yield of strawberry. Application of 0.50% boron maximized fruit yield 117.82 & 118.58 q/ha during respective years of trial. Control produced the minimum of 91.21 & 90.97 q/ha yield. Application of B caused of 29.17, 30.35% improvement in the yield over control. It may be owing to application of boron which is reported to enhance pollen germination, pollen tube growth causing low fruit drop thereby increasing fruit set. The present findings are in accordance with the reports of Yehia and Hassan (2005) and Bhambota (1962) in citrus, Afria (1999) in pomegranate and Yadav *et al.,* (2013) in peach. The interaction between gibberellic acid and boron proved significant and G_2B_3 produced maximum fruit yield 141.65 and 142.17 q/ha followed by G_3B_3 and G_2B_2 against significantly minimum (60.22, 60.72 q/ha) under G_0 B_0 during former and latter years of study.

On the basis of results obtained it is concluded that the individual application of both treatments, GA_3 at 75ppm and boron 0.50% significantly minimized days to flowering, days to fruit setting and maximized number of flower per plant, number of fruit per plant

consequently the fruit yield (q/ha) of strawberry. The plants treated with 75 ppm GA_3 associated with 0.50% boron significantly harvested maximum fruit yield (q/ha) of strawberry as compared to untreated ones.

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