Original Research Article

Influence of foliar spray of Brassinosteroids (BR), Salicylic acid (SA) and Gibberellic acid (GA_3) on vegetative growth and flowering parameters of Cucumber (*Cucumis sativus* L) cv. Arpit.

Abstract

An investigation entitled "Influence of foliar spray of Brassinosteroids (BR), Salicylic acid (SA) and Gibberellic acid (GA_3) on vegetative and flowering parameters of Cucumber (*Cucumis sativus* L) cv. Arpit" was carried out at the Vegetable Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology & Science, Prayagraj, (U.P.) - 211007 during the year 2018-19 and 2019-2020. The experiment was laid out in a Randomized Block Design with 15 treatments and 3 replications and each replicated thrice. Source of variables were Brassinosteroids (BR) 0.05 PPM, Brassinosteroids (BR) 0.10 PPM, Brassinosteroids (BR) 0.5 PPM, Brassinosteroids (BR) 1.0 PPM, Brassinosteroids (BR) 2.0 PPM, Salicylic acid (SA) 0.05 mM, Salicylic acid (SA) 0.10mM, Salicylic acid (SA) 0.2mM, Salicylic acid (SA) 0.5mM, Salicylic acid (SA) 1.0mM, Gibberellic acid (GA3) 25 PPM, Gibberellic acid(GA3) 50 PPM, Gibberellic acid(GA3) 100 PPM, Gibberellic acid (GA3) 150 PPM and combination of them with control treatment taken as 15 treatments. As far as the vegetative growth and flowering is concerned, application of different treatment of plant growth regulators significantly enhanced the Length of main vine (cm), Number of branches per plant, Number of leaves per plant, Diameter of main stem (cm), Inter-nodal distance (cm), Leaf area (cm^2), Days to first flower bud initiate (DAS), Days taken to 50% flowering, Number of male flower per plant, Number of female flower per plant at all successive stages. The maximum vine length (143.17 and 146.04cm), number of leaves per plant (93.74 and 94.74), number of branches per plant (19.49 and 19.82), diameter of main stem (14.70 and 16.02cm), leaf area (277.42 and 280.90 cm^2), internodal distance (7.27 and 6.97cm) and as per flowering parameters lowest days taken to first flower bud initiation (36.66 and 35.73 days), days taken to 50% flowering (42.40 and 422.73 days), number of male flower per plant (91.71 and 92.05) and number of female flower per plant (47.59 and 46.92) were recorded in both successive year with T5 (Brassinosteroids (BR) 2.0 PPM) and minimum growth and flowering were observed in T_0 (control).

Keywords- Cucumber, Vegetative growth, Flowering, Brassinosteroids, Salicylic acid, Gibberellic acid.

Introduction

Cucumber (Cucumis sativus L.) is a cross pollinated and widely grown vegetable crop in the Cucurbitaceae family, with chromosome number 2n=14. It is an indigenous vegetable to India **(De Candole, 1967).** It is often a monoecious, annual, trailing or climbing vine with hirsute or scabrous stems and triangular ovate leaves with shallow and sharp sinuses **(Bailey, 1969).** At the leaf axils, unbranched lateral tendrils appeared. Flower clusters form in leaf axils as the lateral branches grow **(Ahmed et al. 2004).** It is a warm-season crop with minimal to no frost resistance. Cucumber growth and development are aided by temperatures over 20-30°C.

It is widely farmed in the Indian states of Madhya Pradesh, Tamil Nadu, Uttar Pradesh, Andra Pradesh, Kerala, and Maharashtra. It covers an area of 41 million ha in India, produces 641 MT, and has a productivity of 15.63 t/ha **(Handbook of Horticulture Statistics 2019-20).**

Depending on the cultivar, area, and soil climate, the plant begins flowering early and produces marketable fruits within two or three months. Flowering is a critical stage in the development of cucurbits since it determines fruiting and yield. Cucumber is a monoecius plant, which means that the first flowers that develop near the base of a cucumber plant are male. A week after the male flower initiation, the female flowers develop, with the little cucumber fruit at the base **(Bantoc, 1964).** Cucumbers have a high water content while being low in calories, fat, cholesterol, and salt. The fruit is an elongated, round triangular fake berry or pepo. Its size, shape, and colour differ according on the cultivar. Fruits are beneficial to persons who have jaundice, constipation, or indigestion. It is eaten raw with salt and pepper, or as part of a salad with pickles. The fruit pulp is used to make mash cakes.

Cucumber's reaction to plant growth regulators displays a remarkable spectrum of floral morphology, including staminate, pistillate, and hermaphrodite flowers that appear in a variety of configurations and provide a variety of sexual expression. Growth regulators have a huge impact on sex expression and blooming in cucumber crops, either suppressing male flowers or increasing the amount of female flowers **(Al-Masoum & Al-Masri, 1999)** with no negative consequences for the environment or human health. Plant growth regulators are also used to control cucumber plant vegetative development, which increases plant population per unit area in terms of production **(Latimer, 1991).**

Brassinosteroids are present in a variety of species ranging from lower plants to higher plants. They are steroidal plant hormones that help plants grow and develop. BR may show a keen interest in the role of horticulture crops. It was characterised by a decrease in the quantity of male flowers in the early stages of growth and a promotion of female flower initiation in the main stalk. Another study on cucumber found that BS is critical during early fruit development **(Fu *et al.*, 2008).** the treatment of tomato plants with BS, at flowering stage led to the enhancement of the number and weight of tomoto **(Balmush *et al.*, 1995).** The effects of brassinosteroids on both vegetative and reproductive development are investigated and compared to known BR physiological responses such as cell elongation and division, vascular differentiation, blooming, pollen formation, and photomorphogenesis. **(Steven D. clouse 2011).** They also have an impact on cotyledon development, root elongation, leaf creation and growth, and plant biomass. Exogenous BS also enhances the activity of other enzymes such as carbonic anhydrase and nitrate reductase. **(Ali *et al.*, 2006; Alam *et al.*, 2007)**, rubisco **(Yu *et al.*, 2004).** BS have also been found to affect whole physiology of the plant, starting from seed germination to harvest or seed maturation. Application of BS has been found to enhance the seed germination in chickpea **(Ali *et al.*, 2005)**, Indian mutard **(Sirhindi, 2013)** and tobbacco **(Leubner-Metzger, 2001).**

Salicylic acid (SA) is a phytohormone that has recently been added to the family of phytohormones for appropriate plant growth development and induction of tolerance to both biotic and abiotic stresses. Growth-stimulating effects of SA have been reported in soybean **(Gutiérrez-Coronado *et al.*, 1998),** wheat **(Shakirova *et al.*, 2003),** maize **(Gunes *et al.*, 2007).** SA is a phenolic endogenous growth regulator that controls a variety of physiological processes in agricultural plants such as stomatal closure, ion uptake, ethylene biosynthesis inhibition, and transpiration. **(Khan *et al.*, 2003 and Shakirova *et al.*, 2003).** SA found that 4 μM SA promotes flower bud formation from tobacco callus **(Lee and Skoog, 1965).**

Gibberellic acid is important in seed germination, endosperm mobilisation, stem elongation, leaf expansion, shortening maturation time, and boosting flower and fruit set and composition **(Roy & Nasiruddin 2011).** GA3 slows senescence, promotes chloroplast growth and development, and increases photosynthetic efficiency, perhaps leading to enhanced production **(Yuan &Xu 2001).**

Materials and Methods

The experiment entitled "Influence of foliar spray of Brassinosteroids (BR), Salicylic acid (SA) and Gibberellic acid (GA_3) on vegetative and flowering parameters of Cucumber (*Cucumis sativus* L) cv. Arpit**"** was carried out during the summer season of the year 2018-2019 and 2019-20. The experiment was laid out in a Randomized Block Design with 15 treatments and 3 replications and each replicated thrice. Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, provided all of the necessary equipment for the experiment.

It reaching a height of 98 meters above the sea level and is located at 25^{o}.8'N latitude and 81^{o}.50' E longitude. Prayagraj district is situated in Uttar Pradesh's subtropical zone, which has extreme heat summers and mild winters. The area's peak temperature is 46^{o}C–48^{o}C, and it seldom goes below 4^{o}C–5^{o}C. The relative humidity level varies between 20 and 94 percent. The annual average rainfall in this area is 1013.4 mm.

Source of variable were T_0 (Control), T_1 Brassinosteroids 0.05 PPM, T_2 Brassinosteroids 0.10PPM, T_3 Brassinosteroids 0.5 PPM, T_4 Brassinosteroids 1.0 PPM, T_5 Brassinosteroids 2.0PPM, T_6 Salicylic acid 0.05 mM, T_7 Salicylic acid 0.10 mM, T_8 Salicylic acid 0.2 mM, T_9 Salicylic acid 0.5 mM, T_{10} Salicylic acid 1.0mM, T_{11} Gibberellic acid 25 PPM, T_{12} Gibberellic acid 50 PPM, T_{13} Gibberellic acid 100 PPM, T_{14} Gibberellic acid 150 PPM. The observations were recorded on vegetative growth and flowering parameters of cucumber as Vine length (cm), No. of leaves /plant, No. of branches /plant, Diameter of main stem (mm), Internodel distance (cm), Leaf area (cm^2), Days to first flower bud initiation, Days taken to 50% flowering, No. of male flower/plant, No. of female flower/plant were studied in the investigation. Statistical analysis of experiment was laid out in randomized block design with three replications.

Result and Discussion

The data on various observations recorded during experimentation were subjected to statistical analysis in Randomized Block Design in order to find out the significance of different treatments by using the analysis of variance. The results have been integrated along with the corresponding tables. In terms of vegetative parameters, it was found that Vine length, number of leaves, number of branches,

diameter of main stem(mm), Internodal distance(cm) and Leaf area(cm^2) were significantly increased during the both year by different treatments of plant growth regulators at all successive stage of growth.

It is clear from the table 1 that the maximum vine length at 90 days (143.17 cm and 146.04 cm in 2018-19 and 2019-20 respectively and 144.60 cm as pooled) closely conformity to the **Ramani *et al.*,(2016), kumar & kaur (2019) and Hirpara et al., (2014)** Maximum Number of leaves at 90 days (93.74 and 94.74 in 2018-19 and 2019-20 respectively and 94.24 as pooled) closely associated with **Irfan *et al.*, (2017) and Vishnu ritti *et al.*, (2019)**; Number of branches (19.49 and 19.82 in 2018-19 and 2019-20 respectively and 94.24 as pooled) associated with **Ghosh *et al.*,(2020);** maximum Diameter of main stem (14.70 mm and 16.02 mm in 2018-19 and 2019-20 respectively and 15.36 mm when pooled) closely with **Vishnu ritti *et al.*, (2019);** and maximum leaf area (277.42 cm^2 and 280.90 cm^2 in 2018-19 and 2019-20 respectively and 279.16 cm^2 when pooled) close conformity to the **karuppaiah *et al.*, (2019) and khatoon *et al.*, (2020)** and maximum Internodal distance (7.27 and 6.97 in 2018-19 and 2019-20 respectively and 7.12 when pooled) closely associated with **khatoon *et al.*, (2021) and Acharya *et al.*, (2020)** were recorded in T_5 (Brassinosteroids (BR) 2.0 PPM). While minimum Vine length at 90 days (126.62cm, 128.95cm and 127.79cm in 2018-19; 2019-20 and as pooled, respectively), number of leaves (74.53, 75.19 and 74.86 in 2018-19; 2019-20 and as pooled, respectively), Number of branches (12.35, 13.68 and 13.02 in 2018-19, 2019-20 and pooled, respectively), Diameter of main stem (11.05 mm, 11.71mm and 11.38 mm in 2018-19, 2019-20 and pooled, respectively), leaf area (258.07cm^2, 266.07 cm^2 and 262.07 cm^2 in 2018-19, 2019-20 and pooled, respectively), Internodal distance (4.79, 4.39 and 4.59 in 2018-19, 2019-20 and pooled, respectively) were observed with T_0 (Control). According to **Papadopoulou and Grumet (2005),** applying EBL to cucumber plants accelerated and boosted female flower production, and the effects may be mediated, at least in part, by BS-induced ethylene production. Furthermore, external brassinolide treatments were performed on cucumber, melon, and zucchini, and it was discovered that cucumber was more susceptible than zucchini. It was characterised by a decrease in the quantity of male flowers in the early stages of growth and a promotion of female flower initiation in the main stalk. In another study on cucumber, it was demonstrated that BS play an important role during early fruit development **(Fu et al., 2008).** Growth has been suggested to be promoted by increasing the flexibility of the cell wall, followed by

hydrolysis of starch to sugars, which reduces the water potential of the cell, resulting in the entrance of water into the cell, inducing elongation. **Sargent (1965).**

In term of Flowering parameters, it was found that Days to first flower bud initiate (DAS), Days taken to 50 % flowering, Number of male flower per plant, Number of female flower per plant were significantly increased by different treatments of plant growth regulator at all successive stages of growth and flowering in both the individual years and when pooled.

Minimum Days to first flower bud initiate (days) (36.66 days and 35.73 days in 2018-19 and 2019-20 respectively and 36.20 days as pooled) closely associated with **Abdul *et al.*, (2018).** Minimum Days to 50% flowering (days) (42.40 days and 42.73 days in 2018-19 and 2019-20 respectively and 42.57 days as pooled) closely associated with **karuppaiah *et al.*, (2019) and khatoon *et al.*, (2020)** and Maximum Number of male flower per plant (91.71 and 92.05 in 2018-19 and 2019-20 respectively and 91.88 as pooled) close conformity with the **Khan *et al.*, (2006) & Kadi *et al.*, (2018)** Maximum Number of female flower per plant (47.59 and 46.92 in 2018-19 and 2019-20 respectively and 47.26 as pooled) closely associated with **khatoon *et al.*, (2021), singh *et al.*,(2010) and pawar *et al.*,(2019)** were recorded in T_5 (Brassinosteroids (BR) 2.0 PPM). While maximum days to first flower bud initiate (days) (41.40 days and 41.26 days in 2018-19 and 2019-20 respectively and 41.33 days as pooled), maximum days to 50% flowering (days) (46.26 days and 46.53 days in 2018-19 and 2019-20 respectively and 46.40 days as pooled) associated with **Ghorbani *et al.*, (2017)** and minimum Number of male flower per plant (76.41 and 72.07 in 2018-19 and 2019-20 respectively and 74.24 as pooled), minimum Number of female flower per plant (36.32 and 34.65 in 2018-19 and 2019-20 respectively and 35.49 as pooled) were observed with T_0 (Control).

In this study, relatively modest quantities of GA3 delayed the development of the first staminate bloom and increased pistillate flower commencement **(Wang and Zeng 1997).** In other research, treating tomato plants with BS at the blooming stage increased the number and weight of tomatoes **(Balmush *et al.*, 1995).** In field circumstances, the largest crop improvement was obtained when tomato and cucumber plants were treated with EBL twice, first by seed soaking and then by spraying during the flowering stage (Churikova and Derevshchukov, 1997).

Conclusion-

Based on the current experiment, it was established that the treatment T5 (Brassinosteroids (BR) 2.0 PPM) was ideal in terms of vegetative development and flowering characteristics in both the following years 2018-19 and 2019-20 of cucumber. Farmers may be encouraged to utilise those Plant growth regulator combinations after a few more conjoint research.

Table 1:- Influence of foliar spray of Brassinosteroids (BR), Salicylic acid (SA) and Gibberellic acid (GA_3) on vegetative parameters of Cucumber cv. F_1 hybrid Arpit.

Treatment	Vine length 90 days			Number of leaves per plant 90 days			Number of branches per plant 90 days			Daimeter of main stem (mm) 90 days			Leaf area (cm^2) 90 days		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T0	126.62	128.95	127.79	74.53	75.19	74.86	12.35	13.68	13.02	11.05	11.71	11.38	258.07	266.07	262.07
T1	133.91	136.57	135.24	84.57	85.49	85.03	14.81	15.92	15.37	12.64	13.40	13.02	264.43	272.70	268.57
T2	134.57	137.19	135.88	85.28	87.30	86.29	15.24	16.66	15.95	12.99	13.77	13.38	265.60	273.35	269.48
T3	139.39	141.31	140.35	90.19	90.89	90.54	17.33	18.53	17.93	13.47	14.28	13.87	270.87	277.93	274.40
T4	142.00	144.36	143.18	91.34	93.34	92.34	18.10	18.89	18.50	13.85	15.10	14.47	274.23	279.22	276.73
T5	143.17	146.04	144.60	93.74	94.74	94.24	19.49	19.82	19.66	14.70	16.02	15.36	277.42	280.90	279.16
T6	129.65	131.99	130.82	79.79	81.45	80.62	13.74	14.46	14.10	11.73	12.44	12.09	260.36	269.68	265.02
T7	133.56	135.58	134.57	81.15	83.93	82.54	14.39	15.51	14.95	12.40	13.14	12.77	262.35	270.76	266.56
T8	137.08	139.83	138.45	87.65	89.15	88.40	16.08	17.76	16.92	13.15	13.94	13.54	268.35	276.60	272.48
T9	138.10	140.74	139.42	89.99	90.67	90.33	16.84	18.47	17.66	13.33	14.13	13.73	269.43	277.75	273.59
T10	139.96	143.15	141.56	90.33	91.10	90.72	17.58	18.64	18.11	13.56	14.64	14.10	272.73	278.24	275.49
T11	136.52	139.08	137.80	86.01	88.89	87.45	15.76	17.17	16.47	13.07	13.85	13.46	267.68	274.43	271.06
T12	137.78	140.15	138.97	89.25	90.33	89.79	16.33	18.33	17.33	13.25	14.05	13.65	269.22	277.38	273.30
T13	140.31	143.54	141.93	90.60	91.52	91.06	17.75	18.76	18.26	13.67	14.76	14.22	273.38	279.02	276.20
T14	142.49	145.12	143.80	92.43	94.01	93.22	18.69	19.17	18.93	14.13	15.26	14.70	274.91	280.75	277.83
CD value	**6.10**	**6.22**	**6.16**	**3.88**	**3.94**	**3.91**	**0.73**	**0.78**	**0.75**	**0.58**	**0.62**	**0.60**	**8.59**	**5.50**	**6.58**
S.Ed (±)	**2.98**	**3.03**	**3.01**	**1.89**	**1.92**	**1.91**	**0.35**	**0.38**	**0.37**	**0.29**	**0.30**	**0.30**	**4.19**	**2.68**	**3.21**

Table 2:- Influence of foliar spray of Brassinosteroids (BR), Salicylic acid (SA) and Gibberellic acid (GA_3) on flowering parameters of Cucumber cv. F_1 hybrid Arpit.

Treatment	Internodal distance (mm)			Days taken to first flower bud initiation (days)			Days taken to 50% flowering (days)			Number of male flower per plant			Number of female flower per plant		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T0	4.79	4.39	4.59	41.40	41.26	41.33	46.26	46.53	46.40	76.41	72.07	74.24	36.32	34.65	35.49
T1	5.18	4.96	5.07	40.33	40.00	40.17	45.86	45.38	45.62	84.65	84.27	84.46	41.65	40.20	40.93
T2	5.29	5.01	5.15	40.26	39.80	40.03	45.72	45.13	45.43	85.08	84.91	85.00	41.75	40.41	41.08
T3	6.20	6.11	6.16	38.86	38.53	38.70	44.73	44.63	44.68	87.90	86.18	87.04	43.38	42.38	42.88
T4	6.78	6.38	6.58	38.43	38.30	38.36	44.46	43.73	44.10	89.89	88.36	89.13	45.01	42.74	43.88
T5	7.27	6.97	7.12	36.66	35.73	36.20	42.40	42.73	42.57	91.71	92.05	91.88	47.59	46.92	47.26
T6	5.12	4.78	4.95	41.00	40.33	40.67	46.20	46.20	46.20	81.48	80.48	80.98	40.64	38.64	39.64
T7	5.13	4.85	4.99	40.66	40.23	40.45	45.86	46.09	45.98	83.27	83.74	83.51	40.87	40.18	40.53
T8	5.38	5.13	5.26	39.93	39.06	39.50	45.06	44.86	44.96	86.18	85.65	85.92	42.75	41.40	42.08
T9	6.11	5.78	5.95	38.61	38.68	38.65	44.86	44.73	44.80	87.72	85.85	86.79	43.07	42.30	42.69
T10	6.50	6.13	6.32	38.43	38.53	38.48	44.63	44.33	44.48	88.85	87.72	88.29	44.63	42.41	43.52
T11	5.35	5.05	5.20	40.06	39.33	39.70	45.53	44.94	45.24	85.30	85.64	85.47	42.31	40.65	41.48
T12	5.78	5.53	5.66	39.53	38.93	39.23	44.94	44.75	44.85	86.99	85.66	86.33	42.85	41.65	42.25
T13	6.71	6.27	6.49	38.42	38.19	38.31	44.53	44.27	44.40	89.69	87.90	88.80	44.97	42.63	43.80
T14	6.97	6.50	6.74	38.13	37.86	38.00	44.00	43.65	43.83	90.24	90.23	90.24	47.07	43.43	45.25
CD value	**0.26**	**0.25**	**0.26**	**1.87**	**1.75**	**1.76**	**2.01**	**2.00**	**2.01**	**3.85**	**3.80**	**3.82**	**1.91**	**1.84**	**1.88**
S.Ed (±)	**0.13**	**0.12**	**0.13**	**0.91**	**0.85**	**0.86**	**0.98**	**0.98**	**0.98**	**1.88**	**1.86**	**1.87**	**0.93**	**0.90**	**0.92**

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