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Saurabh Toppo
Ph.D., Scholar, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattishgarh, India

Annu Verma
Associate Professor, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattishgarh, India

Corresponding Author:
Saurabh Toppo
Ph.D., Scholar, Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattishgarh, India

Studies on combined effect of potassium and gibberellic acid on quality parameters in parthenocarpic cucumber (*Cucumis sativus* L.) cv. Sania (F1) under low poly tunnel

Saurabh Toppo and Annu Verma

Abstract
A field experiment was conducted to study the combined effect of Potassium and Gibberellic acid on quality parameters in parthenocarpic cucumber (*Cucumis sativus* L.) cv. Sania (F1) under low poly tunnel. This experiment was carried out under low poly tunnel during 2019-20 and 2020-21 at Centre of Excellence on Protected Cultivation and Precision Farming, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was laid out in a Factorial Randomized Block Design replicated thrice with ten treatments i.e. Control (Water spray), T2 - (Potassium 1000 $g.dm^{-3}$ + GA_3 5 $g.dm^{-3}$), T3 - (Potassium 2500 $g.dm^{-3}$ + GA_3 5 $g.dm^{-3}$), T4 - (Potassium 5000 $g.dm^{-3}$ + GA_3 5 $g.dm^{-3}$), T5 - (Potassium 1000 $g.dm^{-3}$+ GA_3 10 $g.dm^{-3}$), T6 - (Potassium 2500 $g.dm^{-3}$ + GA_3 10 $g.dm^{-3}$), T7 - (Potassium 5000 $g.dm^{-3}$ + GA_3 10 $g.dm^{-3}$), T8 - (Potassium 1000 $g.dm^{-3}$ + GA_3 15 $g.dm^{-3}$), T9 - (Potassium 2500 $g.dm^{-3}$ + GA_3 15 $g.dm^{-3}$), T10 - (Potassium 5000 $g.dm^{-3}$ + GA_3 15 $g.dm^{-3}$). The result shows that maximum protein was recorded (27.20% and 29.80%) in T7, maximum total sugar was recorded (33.38% and 33.68%) in T10, maximum reducing sugar was recorded (6.87% and 6.82%) in T10, maximum non reducing sugar was recorded (26.52% and 26.29%) in T10, maximum ascorbic acid was recorded (3.07% and 3.08%) in T10 during both the year. It is concluded that among several treatments T10 was found superior over others in quality parameters such as Total Sugar, Reducing Sugar, Non-Reducing Sugar, Ascorbic acid and T7 was found superior over others in Protein.

Keywords: Gibberellic acid, Potassium, Protein, starch etc.

Introduction
Cucumber (*Cucumis sativus*), an annual trailing vine vegetable belonging to Cucurbitaceae family, is the most widely grown vegetable of the family after watermelon. The demand and supply for cucumber has been expeditiously increased in the last few years and now it is grown throughout the world using fields or greenhouse culture. It has a diploid chromosome number of 14, 2n= 14 (Kadi *et al.*, 2018) [2]. Although it is very watery, with little flavor and not very nutritious, it is a common ingredient of salads and pickles, being valued primarily for its crisp texture and juiciness. The fruits are extremely nutritive and con-sist of 95% water, extremely small calories (about 15 calories per cup) reported by Mukherjee *et al.* (2013) [4]. The fruit also consists of calcium (20mg/100g), iron (0.7mg/100g), thiamin (0.3mg/100g), niacin (0.01mg/100gm) and some natural antioxidants that reduce chronic diseases (Trichopoulou *et al.*, 2000; Mia *et al.*, 2014) [7, 3]. It is very rich in antioxidants and vitamin K and C (Jyoti *et al.*, 2016) [1]. The major problem is maleness in cucumber which greatly decrease the fruit yield (Singh *et al.*, 2015) [6]. The cucumber grows best in a semitropical climate. It flourishes well under environment of high temperature, humidity, and light intensity and with an uninterrupted irrigations and appropriate nutrients supply. Under favourable and suitable climatic and nutritional conditions and when pests are under control, the plants grow fast and yield heavily. Under excellent environments, more fruit may initially develop, so fruit may need thinning. Plants allowed to bear too much fruit become exhausted, abort fruit, and fluctuate widely in productivity over time. On the other hand, cucumbers are very sensitive to unfavourable environments, and the slightest stress has negative impacts on their growth and fruit yield. When cucumber could not meet the criteria of these environmental requirements, the effects are seen in the growth pattern, fruiting, flowering, and fruit yield and hence the need of application of PGRs will emerge whose applications shape the growth and development of the plants in right way.

PGRs such as gibberellin include many aspects of plant growth and development. They are organic substances that are used in low concentration to change the plant growth usually by stimulating part of the natural growth regulatory system. Due to the importance of plant growth regulators has been classified and inadequate data on the effect of PGRs on growth and yield in cucumber was observed. Therefore, an experiment was laid out to find out their impact of growth and yield of cucumber.

Materials and Methods

The proposed experiment was conducted under low poly tunnel during 2019-20 and 2020-21 at Centre of Excellence on Protected Cultivation and Precision Farming, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.).

The experimental material consisted of Sania (F1) cultivar of cucumber, Potassium and gibberellic acid. Experiment was laid out in Factorial Randomized Block Design with additional treatment as control versus others having three replications. Foliar spray of three concentration of gibberellic acid (G1-5 $g.dm^{-3}$, G2 - 10 $g.dm^{-3}$, G3 - 15 $g.dm^{-3}$) and potassium (K1 - 1000 $g.dm^{-3}$, K2 - 2500 $g.dm^{-3}$, K3 - 5000 $g.dm^{-3}$) each were performed in cucumber plant. Spraying of K was performed twice a week, 1st after 20 days of sowing. Spraying of GA_3 was performed twice. 1st on the 30th day after sowing and then on the 60th day. Cucumber was transplanted at a spacing of 1 m x 0.50 m. Data were recorded on 5 important characters related to quality characters during the course of investigation which were subjected to statistical analysis of two years and pooled mean data using suitable techniques of different characters.

Results and Discussion

Protein was significantly affected due to treatment with potassium, gibberellic acid and combination of potassium and gibberellic acid treatment during the year 2019-20 and 2020-21. Among potassium treatments, maximum protein was recorded (22.63% and 27.13%) in K3 – 5000 $g.dm^{-3}$ which differed significantly with K2 – 2500 $g.dm^{-3}$ (18.59% and 24.67%) followed by K1 – 1000 $g.dm^{-3}$ (16.28% and 23.13%) during 2019-20 and 2020-21, respectively.

Among gibberellic acid treatments, maximum protein was recorded (21.33% and 26.30%) in G2 – 10 $g.dm^{-3}$ followed by G3 – 15 $g.dm^{-3}$ (19.32% and 25.13%) which differed significantly with G1 – 5 $g.dm^{-3}$ (16.85% and 23.50%) during 2019-20 and 2020-21, respectively.

Among different combinations of potassium and gibberellic acid, maximum protein was recorded (27.20% and 29.80%) in T7 – 10 $g.dm^{-3}$ + 5000 $g.dm^{-3}$ followed by T10 (21.63% and 26.60%), T6 (19.99% and 25.60%), in year 2019-20 and 2020-21, respectively. Under these combinations, minimum protein was recorded (15.39% and 22.50%) in T2 during 2019-20 and 2020-21, respectively.

Minimum protein (12.73% and 20.50%) was recorded in T1 - water sprayed (control) as compared to other treatments during 2019-20 and 2020-21. Similar opinion was reported by Pal *et al.*, 2018 in cucumber.

Total sugar was not significantly affected due to treatment with potassium, gibberellic acid and combination of potassium and gibberellic acid treatment. Among potassium treatments, maximum total sugar was recorded (32.36% and 32.59%) in K3 – 5000 $g.dm^{-3}$ followed by K2 – 2500 $g.dm^{-3}$ (30.47% and 30.43%), K1 – 1000 $g.dm^{-3}$ (28.88% and 28.78%) during 2019-20 and 2020-21, respectively.

Among gibberellic acid treatments, maximum total sugar was recorded (32.13% and 32.04%) in G3 – 15 $g.dm^{-3}$ followed by G2 – 10 $g.dm^{-3}$ (31.36% and 31.45%), G1 – 5 $g.dm^{-3}$ (28.22% and 28.32%) during 2019-20 and 2020-21, respectively.

Among different combinations of potassium and gibberellic acid, maximum total sugar was recorded (33.38% and 33.68%) in T10 – 15 $g.dm^{-3}$ + 5000 $g.dm^{-3}$ followed by T7 (32.55% and 33.05%), T9 (32.30% and 32.32%), in year 2019-20 and 2020-21, respectively. Under these combinations, minimum total sugar was recorded (26.72% and 26.89%) in T2 during 2019-20 and 2020-21, respectively.

Minimum total sugar (26.63% and 26.66%) was recorded in T1 - water sprayed (control) as compared to other treatments during 2019-20 and 2020-21. Gibberellic acid increased the total sugar content of fruit and this finding was similar with Vadigeri *et al.*, 2001.

Reducing sugar was not significantly affected due to treatment with potassium, gibberellic acid and combination of potassium and gibberellic acid treatment. Among potassium treatments, maximum reducing sugar was recorded (6.66% and 6.66%) in K3 – 5000 $g.dm^{-3}$ followed by K2 – 2500 $g.dm^{-3}$ (6.28% and 6.34%), K1 – 1000 $g.dm^{-3}$ (5.97% and 5.95%) during 2019-20 and 2020-21, respectively.

Among gibberellic acid treatments, maximum reducing sugar was recorded (6.62% and 6.64%) in G3 – 15 $g.dm^{-3}$ followed by G2 – 10 $g.dm^{-3}$ (6.46% and 6.46%), G1 – 5 $g.dm^{-3}$ (5.83% and 5.84%) during 2019-20 and 2020-21, respectively.

Among different combinations of potassium and gibberellic acid, maximum reducing sugar was recorded (6.87% and 6.82%) in T10 – 15 $g.dm^{-3}$ + 5000 $g.dm^{-3}$ followed by T7 (6.70% and 6.75%), T9 (6.65% and 6.74%), in year 2019-20 and 2020-21, respectively. Under these combinations, minimum reducing sugar was recorded (5.53% and 5.51%) in T2 during 2019-20 and 2020-21, respectively.

Minimum reducing sugar (5.52% and 5.43%) was recorded in T1 - water sprayed (control) as compared to other treatments during 2019-20 and 2020-21.

Non reducing sugar was not significantly affected due to treatment with potassium, gibberellic acid and combination of potassium and gibberellic acid treatment. Among potassium treatments, maximum non reducing sugar was recorded (25.69% and 25.75%) in K3 – 5000 $g.dm^{-3}$ followed by K2 – 2500 $g.dm^{-3}$ (24.18% and 24.23%), K1 – 1000 $g.dm^{-3}$ (22.92% and 22.70%) during 2019-20 and 2020-21, respectively.

Among gibberellic acid treatments, maximum non reducing sugar was recorded (25.52% and 25.49%) in G3 – 15 $g.dm^{-3}$ followed by G2 – 10 $g.dm^{-3}$ (24.89% and 24.73%), G1 – 5 $g.dm^{-3}$ (22.38% and 22.46%) during 2019-20 and 2020-21, respectively.

Among different combinations of potassium and gibberellic acid, maximum non reducing sugar was recorded (26.52% and 26.29%) in T10 – 15 $g.dm^{-3}$ + 5000 $g.dm^{-3}$ followed by T7 (25.85% and 26.01%), T9 (25.65% and 25.81%), in year 2019-20 and 2020-21, respectively. Under these combinations, minimum non reducing sugar was recorded (21.18% and 21.08%) in T2 during 2019-20 and 2020-21, respectively.

Minimum non reducing sugar (21.12% and 21.02%) was recorded in T1 - water sprayed (control) as compared to other treatments during 2019-20 and 2020-21.

Ascorbic acid was not significantly affected due to treatment with potassium, gibberellic acid and combination of potassium and gibberellic acid treatment. Among potassium treatments, maximum ascorbic acid was recorded (2.92% and 2.92%) in K3 – 5000 g.dm^{-3} followed by K2 – 2500 g.dm^{-3} (2.74% and 2.74%), K1 – 1000 g.dm^{-3} (2.46% and 2.45%) during 2019-20 and 2020-21, respectively.

Among gibberellic acid treatments, maximum ascorbic acid was recorded (2.89% and 2.89%) in G3 – 15 g.dm^{-3} followed by G2 – 10 g.dm^{-3} (2.78% and 2.76%), G1 – 5 g.dm^{-3} (2.46% and 2.46%) during 2019-20 and 2020-21, respectively.

Among different combinations of potassium and gibberellic acid, maximum ascorbic acid was recorded (3.07% and 3.08%) in T10 – 15 g.dm^{-3} + 5000 g.dm^{-3} followed by T7 (3.00% and 2.96%), T9 (2.97% and 2.96%), in year 2019-20 and 2020-21, respectively. Under these combinations, minimum ascorbic acid was recorded (2.30% and 2.29%) in T2 during 2019-20 and 2020-21, respectively.

Minimum ascorbic acid (2.27% and 2.20%) was recorded in T1 - water sprayed (control) as compared to other treatments during 2019-20 and 2020-21. Gibberellic acid increased the ascorbic acid content of fruit and this finding was similar with Vadigeri *et al.,* 2001.

Table 1: Mean performance of Protein (%) in parthenocarpic cucumber

Treatments	**1ST Year**	**2ND Year**	**Pooled Mean Performance**
Potassium			
K1(1000g.dm^{-3})	16.28^{c}	23.13^{c}	19.71^{c}
K2(2500g.dm^{-3})	18.59^{b}	24.67^{b}	21.63^{b}
K3(5000g.dm^{-3})	22.63^{a}	27.13^{a}	24.88^{a}
Sem±	0.12	0.08	0.05
CD (0.05)	1.06	0.68	0.60
GA_3			
G1(5g.dm^{-3})	16.85^{c}	23.50^{c}	20.17^{c}
G2(10g.dm^{-3})	21.33^{a}	26.30^{a}	23.82^{a}
G3(15g.dm^{-3})	19.32^{b}	25.13^{b}	22.23^{b}
Sem±	0.12	0.08	0.05
CD (0.05)	1.06	0.68	0.60
Interaction			
T2(1000g.dm^{-3} +5g.dm^{-3})	15.39^{d}	22.50^{d}	18.95^{de}
T3(2500g.dm^{-3}+5g.dm^{-3})	16.10^{d}	23.00^{d}	19.55^{d}
T4(5000g.dm^{-3}+5g.dm^{-3})	19.05^{bc}	25.00^{bc}	22.03^{c}
T5(1000g.dm^{-3}+10g.dm^{-3})	16.80^{d}	23.50^{d}	20.15^{d}
T6(2500g.dm^{-3}+10g.dm^{-3})	19.99^{b}	25.60^{b}	22.80^{c}
T7(5000g.dm^{-3}+10g.dm^{-3})	27.20^{a}	29.80^{a}	28.50^{a}
T8(1000g.dm^{-3}+15g.dm^{-3})	16.66^{d}	23.40^{d}	20.03^{d}
T9(2500g.dm^{-3}+15g.dm^{-3})	19.68^{bc}	25.40^{bc}	22.54^{c}
T10(5000g.dm^{-3}+15g.dm^{-3})	21.63^{b}	26.60^{b}	24.12^{b}
Sem±	0.35	0.23	0.15
CD (0.05)	1.83	1.17	1.04
T1 (Control)	12.73	20.50	16.62
Sem±	0.04	0.03	0.02
CD (0.05)	0.83	0.53	0.64

Table 2: Pooled mean performance of quality parameters in parthenocarpic cucumber

Treatments	**Total Sugar**	**Reducing sugar**	**Non-Reducing Sugar**	**Ascorbic Acid**
Potassium				
K1(1000g.dm^{-3})	28.83	5.96	22.81	2.45
K2(2500g.dm^{-3})	30.45	6.31	24.21	2.74
K3(5000g.dm^{-3})	32.47	6.66	25.72	2.92
Sem±	0.30	0.06	0.24	0.03
CD (0.05)	NS	NS	NS	NS
GA_3				
G1(5g.dm^{-3})	28.27	5.84	22.42	2.46
G2(10g.dm^{-3})	31.40	6.46	24.81	2.77
G3(15g.dm^{-3})	32.09	6.63	25.50	2.89
Sem±	0.30	0.06	0.24	0.03
CD (0.05)	NS	NS	NS	NS
Interaction				
T2(5g.dm^{-3}+1000g.dm^{-3})	26.80	5.52	21.13	2.30
T3(5g.dm^{-3}+2500g.dm^{-3})	26.91	5.57	21.30	2.37
T4(5g.dm^{-3}+5000g.dm^{-3})	31.09	6.41	24.84	2.70
T5(10g.dm^{-3}+1000g.dm^{-3})	29.27	5.99	22.92	2.44
T6(10g.dm^{-3}+2500g.dm^{-3})	32.13	6.66	25.59	2.89
T7(10g.dm^{-3}+5000g.dm^{-3})	32.80	6.73	25.93	2.98
T8(15g.dm^{-3}+1000g.dm^{-3})	30.43	6.35	24.38	2.63
T9(15g.dm^{-3}+2500g.dm^{-3})	32.31	6.69	25.73	2.96
T10(15g.dm^{-3}+5000g.dm^{-3})	33.53	6.84	26.40	3.08
Sem±	0.89	0.18	0.71	0.09
CD (0.05)	NS	NS	NS	NS

T1 (Control)	26.64	5.47	21.07	2.23
Sem±	0.10	0.02	0.08	0.01
CD (0.05)	NS	NS	NS	NS

Conclusion

It is concluded that among several treatments T10 (5000 g.dm^{-3} + 15 g.dm^{-3}) was found superior over others in quality parameters such as Total Sugar, Reducing Sugar, Non-Reducing Sugar, Ascorbic acid and T7(5000 g.dm^{-3} + 10 g.dm^{-3}) was found superior over others in Protein.

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