EFFECT OF ACTIVATED CHARCOAL ON GROWTH,YIELD, QUALITY AND DISEASE INCIDENCES OF PARTHENOCARPIC HYBRID CUCUMBER UNDER PROTECTED CONDITION

Abstract

This study was carried out from January to March in the year 2023 to investigate the effect of different levels of activated charcoal on the growth, yield, and quality of Parthenocarpichybrid cucumber variety SFC-2125 (FITO) and to estimate the economics of crop. The research revealed that activated charcoal had significant effect on Treatment-5 (5g activated charcoal per plant) which performed best in terms of growth parameters with maximum Vine length 136.39 cm, number of nodes 17.52, maximum chlorophyll content 57.68, shortest duration for flowering 31.30 days and fruit setting 33.41 days, maximum number offemale flower per plant (46.50), fruits per plant (37.67),fruit length(16.82cm) ,number of fruit yield per plot 19.10 kg, and dry matter content (5.88%). The highest benefit cost ratio was at 3.86 in the same treatment.

1.INTRODUCTION

Cucumber, *Cucumissativus* L., is a member of the cucurbitaceae, which comprises 90 genera and 750 species. It is one of the oldest cultivated vegetable cropsis cultivated in nearly all countries of temperature zones. It is a thermophilic and frost-susceptible plant species, growing best at temperatures above 20 °C. The taste and demands of the consumer vary according to country. Special varieties must be bred that set fruit under suboptimal temperature conditions.

Cucumbers for salads usually have much smoother skins. These varieties would have a more consistent dark green color from tip to tip. Cucumber is a vining, warm-season annual plant in the Cucurbitaceae family cultivated for its edible cucumber fruit. Cucumbers are vining plants with large leaves and curling tendrils. The plant's main stems can have four or five branches from which the tendrils branch. The plant's leaves are alternately arranged on the vines, have 3–7 pointed lobes, and are hairy. Cucumber plants grow yellow flowers with a diameter of 4 cm (1.6 in).

Parthenocarpy is an important agronomic trait in cucumberproduction. However, the systematic identification of parthenocarpic germplasms from national gene banks for cucumber improvement remains an international challenge. In this study, 201 cucumber lines were investigated, including different ecotypes. The percentages of parthenocarpic fruit set (PFS) and parthenocarpic fruit expansion (PFE) were evaluated in three experiments. In natural populations, the PFS rates fit a normal distribution, while PFE rates showed a skewed distribution, suggesting that both PFS and PFE rates are typical quantitative traits. Genetic analysis showed that parthenocarpy in different ecotypes was inherited in a similar incompletely dominant manner.

Parthenocarpic cucumbers, which also produce female only flowers but don't need to be pollinated. The result is, they produce seedless or virtually seedless fruits. For this reason, it's easy to immediately see the advantage of growing Parthenocarpic cucumbers over other types. Additionally, breeding aims such as parthenocarpy, constancy of femaleness, germination, and fruit set at suboptimum temperatures may be of importance in special breeding programs. Unlike many other plant species, there are different sex types in cucumber, which are of different value in breeding and concerning yield potential.

Parthenocarpy along with gynoecious sex expression is an asset for protected cultivation of cucumber. Cultivation of parthenocarpic hybrids is gaining attention of the growers as it is a reliable and profitable venture. Cucumber is a widely cultivated vegetable globally. Our approaches could help increase efficiency and lead to parthenocarpy improvements for modern cucumber cultivars.

Parthenocarpic cucumbers are hybrids and because the cucumbers from these plants produce very few seeds, they are generally more expensive to produce. The upside is you can expect a bigger crop of tasty, almost fully fleshed cucumbers, with virtually no seeds. The real benefits to the grower is that Parthenocarpic cucumbers can be successfully grown under cover, where exposure to insect pollination is much less likely.

Cucumbers that are grown in a protected environment, such as a greenhouse or poly-tunnel, will very often be of a higher quality than those grown outdoors. Commercially, they are much more acceptable to the market but amateur growers can also benefit in knowing that their Parthenocarpic cucumber plants will produce excellent fruits without requiring any pollinating intervention from them.

Activated charcoal is an unprocessed type of carbon used as a mild soil amendment. Activated Charcoal is excellent for soil detoxification natural insecticide and soil conditioner. It is slow to decompose, help drainage and provides some air circulation. Keep nutrients in the soil and that way increase soil fertility. Enhance darning and retain moisture of soil. Allow the flow of air through the potting mix. Help to increase the soil pH Increase soil water holding capacity. Encourage root growth, beneficial soil bacteria and symbiotic fungi Enhance drainage of plants. It has great absorbing and neutralizing capabilities which make it excellent for improving soil health. So, this experiment was conducted to evaluate.

2. MATERIALS AND METHODS

The experiment entitled was carried out from January to March in the year 2023 at Horticulture Research Farm. Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology andSciences, Prayagraj(U.P.).

Prayagraj is situated at an elevation of 78 meters above sea level at 25.870 North latitude and 81.150 E longitudes. This region has a sub-tropical climate prevailing in the South-East part of U.P. with both the extremes in temperature, i.e., the winter and the summer. In cold winters, the temperature sometimes is as low as 32°F (0°C) in December – January and very hot summer with temperature reaching up to 115° F(46°C)in the months of May and June. During winter, frosts and during summer, hot scorching winds are also not uncommon. The average annual rainfall is approximately 1013.4 centimetres, with the heaviest rainfall occurring from July to September and occasional showers in winter. The experimental field has an even topography with a gentle slope and good drainage. The sample were drowned from each replication of experimental plot at 0-15 cm depth before sowing of the crop and a composite sample was made to determine the physical and chemical properties of soil. The soil pH of approximately 6.8. Soil characteristics for the experiment were analysed in the Soil Science department. The experimental site experiences a subtropical climate, with three distinct seasons: winter from November to February, the pre-monsoon or hot season from March to April, and the monsoon period from May to October. Ten treatments were used, including a control (Table 1) and three replications in a completely randomised design with a spacing of 60×30 cm were applied at 2 true leaf stageunder protected conditions, parthenocarpichybrid cucumber (*Cucumissativus* L.) var. SFC-2125 (FITO) Each treatment group consisted of six plants for the observationalrecording of metrics related to Growth, earliness, yield, quality, economic andQualityparameters viz. Total Soluble Solids (TSS) were determined using a refractometer,Dry matter content analysed through muffle furnace, while the vitamin C content was assessed through the titration method recommended by Rangana . The readings for chlorophyll content per leaf were taken using a SPAD-502 meter. The information gathered throughout the inquiry was exposed to Fisher’s description of statistical analysis of variance (ANOVA).

Table 1.Treatment combinations:-

TREATMENT	COMBINATION
T0	No Treatment (only NPK)

T1	1 g activated charcoal / plant
T2	2 g activated charcoal / plant
T3	3 g activated charcoal / plant
T4	4 g activated charcoal / plant
T5	5 g activated charcoal / plant
T6	6 g activated charcoal / plant
T7	7 g activated charcoal / plant
T8	8 g activated charcoal / plant
T9	9 g activated charcoal / plant

3. RESULT AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height

Table 2 presents notable variations in vine length, with the most substantial measurement observed 45 days after sowing. Specifically, T5 (5 g activated charcoal/ plant) exhibited the longest vine Length, reaching 136.39 cm, followed by T1(1 g activated charcoal/ plant) with a measurement of 135.52 cm.In contrast, the control group T8 (8 g activated charcoal/ plant) recorded a shorter vine length of 128.26 cm according to the data in Table 2. The promotary effects of activated charcoal on morphogenesis may be mainly due to its irreversible adsorption of inhibitory compounds and substantially decreasing the toxic metabolites. In addition to this activated charcoal is involved in a number of stimulatory and inhibitory activities including the release of substances naturally present in activated charcoal which promote plant growthand adsorption of vitamins, metal ions

3.1.2 Number of primary branches

Table 2 presents notable variations in the mean of the number of branches, with the most substantial measurement observed 45 days after sowing. Specifically, T5 (5 g activated charcoal /plant) exhibited the highest number reaching 16.82 followed by T6 (3 g activated charcoal /plant) with a number of 15.89 In contrast, the control group (T2) has a minimum number of 14.34 according to the data in Table 2. There exists a direct correlation between the main vine and the formation of Primary branches in plants. This means that an increase in the length of the main vine leads to a corresponding increase in the number of primary branches, and vice versa.Therefore, more length of vine causes more number of primary branches by use of combined dose of T5 (5 g activated charcoal per plant).

3.1.3 Number of nodes

At the 45-day mark post-transplantation, the highest node count was documented in T5 (5 g activated charcoal/ plant), reaching 17.52, followed by T3 (3 g activated charcoal/ plant) reaching 16.56. In contrast, the minimum number of nodes was observed in T2 (2g activated charcoal/plant) registering 14.34.Activated charcoal promote in vitro growth, release of growth promoting substances present in or adsorbed by activated charcoal.

3.1.4 Chlorophyll content (SPAD value)

The SPAD-502 meter, a portable device, is extensively utilized for swiftly and accurately gauging leaf chlorophyll levels without causing damage. Readings from the SPAD-502meter yield relative values directly correlating to the chlorophyll content within the leaf. While taking the readings for Chlorophyll content per leaf using a SPAD-502 meter, the following observations were recorded. The maximum reading was recorded in treatment T5 (5g activated charcoal/ plant) at 57.68, followed by T7 at 53.07 The minimum recording was recorded in treatment T4 (control) at 47.68 .leaves play a crucial role in various plant activities, including photosynthesis, respiration, and transpiration. The application of activated charcoal enhances leaf photosynthetic performance, potentially through the increase in leaf area and chlorophyll content.

3.2 Earliness Parameters

3.2.1 Days to first flowering

The data regarding the days taken for the first appearance of female flowers reveals a statistically significant outcome. The shortest duration for the emergence of the first female flowering was observed in T5 (5 g activated charcoal /plant) at 31.30days (mean), followed by T9(9g activated charcoal/plant) at 31.38 days (mean), while the Longest duration was noted in T6(6g activated charcoal/plant) at 32.67 days (mean), as presented in Table 2. Parthenocarpic cucumbers, which also produce female only flowers but don't need to be pollinated. The result is, they produce seedless or virtually seedless fruits. This development of cucumber flowers is significantly influenced by activated charcoal.

3.2.2 Days to first fruit setting

The analysis of data revealed that the shortest duration for fruit setting was observed in the Treatment-5(T5) at 33.41 days (mean), and followed by Treatment-0 at 33.44 days (mean),whereas the minimum duration was recorded in treatment T6 at 35.11 days (mean). Activated charcoal has been widely utilised to achieve successful fruit setting in parthenocarpic hybrid cucumbers.These varieties produce fruit without the need for pollination.Here the fruit develops in the absence of fertilized seed.

3.2.3 Days to first fruit picking

The analysis of data revealed that the shortest duration for the first fruit picking was observed in the Treatment-5 (42.56) and followed by the Treatment-4 (43.16) and Minimum was recorded in the Treatment-6 (44.24).The activated charcoal found in optimum Concentration that allows them a good assimilation of the nutrients thus contributing to a better synthesis of carbonaceous substances accumulated in the fruits.

3.3 Yield Parameters

3.3.1 Number of female flowers per plant

The Maximum numbers of female flower recorded in theTreatment-5 (46.50) and followed by the Treatment-0(45.67) and Minimum was recorded in the Treatment- 4 and Treatment-9(45.19). Additionally, activated charcoal plays a crucial role in the growth and differentiation of carpels, fostering the development of more female flowers. The results showed that activated charcoal application favourably affects the yield attributes and promote floweringwith the highest values found in the protected condition.

3.3.2 Average fruit weight (g)

The Maximum Fruit weight(g) was recorded in the Treatment 6 (197.41) and Followed by the Treatment 5 (191.09) and Minimum was recorded in the Treatment-0 (181.08). By application of activated charcoal into the orchard soil, this ensure the nitrogen fixation and its progressive release to the plants, as a replacement for manure use. This, in turn, improves the seed setting rate andcontributes to an increase in fruit weight.

3.3.3 Number of fruits per plant

The analysis of the data revealed that the Maximumnumber of Fruit per plant was recorded in the Treatment-5 (37.67) and Followed by the, Treatment- 8 (37.33) and Minimum was recorded and Followed by the, Treatment-6 (35.67) Activated charcoal is involved in a number of stimulatory and inhibitory activities including the release of substances naturally present in activated charcoal which promote growth fruit yield.

3.3.4 Fruit yield per plot (kg)

The analysis of the data revealed that the maximum number of fruits per plot was recorded in treatment T5 (5 g activated charcoal per plant), reaching19.10 kg. Following closely was T4 (4 g activated charcoal /plant) with 19.08 kg of fruits per plant. In contrast, the minimum number of fruits per plant was found in treatment T9 at 17.47 kg.The application of activated charcoal had a significant positive variation in fruit yield due to number of fruits per Plant, yield per plant and number of fruits per plot.

3.3.5 Fruit length (cm)

The analysis of the data revealed that the maximum fruit length was recorded in treatment T5 (5 g activated charcoal/plant) at 16.82 cm, closely followed by T4 (4g activated charcoal/ plant) with a length of 16.39 cm. In contrast, the minimum fruit length was found in treatment T0 at 15.12cm. Fruit length is a significant agronomic trait in cucumber breeding.

3.3.6 Fruit diameter (cm)

The data analysis indicated that the maximum fruit diameter was recorded in treatment T5 (5g activated charcoal/ plant) 4.48 cm. followed by T6 (6g activated charcoal/ plant) with a diameter of 4.38 cm. In contrast, the minimum fruit diameter was observed in treatment T8 (7g activated charcoal/ plant) and T3 (3g activated charcoal/ plant) at 4.23 cm. The application of activated charcoal had a significant effect in fruit yield, fruit length and fruit diameter

Table 2: Effect of activated charcoal on growth parameters of Parthenocarpic hybrid cucumber

Treatment	Plant height (cm)	Number of primary branches	Number of nodes	Chlorophyll content
T0	134.89	15.79	15.85	50.98
T1	135.53	14.56	14.56	50.92
T2	134.71	14.34	14.34	51.91
T3	132.25	14.40	16.56	48.79
T4	132.14	14.87	15.64	47.68
T5	136.39	16.82	17.52	57.68
T6	134.52	15.89	14.67	49.79
T7	132.83	15.00	15.11	53.07
T8	128.26	14.90	14.76	52.71
T9	133.74	14.53	14.67	49.92
F test	S	S	S	S
S.E (d) (±)	0.46	0.31	0.41	0.81
CD 0.05	0.97	0.66	0.86	1.69
C.V	0.42	2.53	3.26	1.92

Table 3: Effect of activated charcoal on earliness parameters of Parthenocarpic hybrid cucumber

Treatment	Days to first flowering	Days to first fruiting	Days to first fruit picking

T0	32.21	33.44	43.45
T1	32.25	33.56	43.24
T2	32.51	34.10	43.99
T3	32.09	34.85	43.18
T4	32.14	34.98	43.16
T5	31.30	33.41	42.56
T6	32.67	35.11	44.24
T7	32.08	34.44	43.25
T8	32.05	33.56	43.33
T9	31.38	34.67	43.34
F test	S	S	S
S.E (d) (±)	0.20	0.31	0.26
CD 0.05	0.66	1.13	0.55
C.V	0.66	1.92	0.75

Table 4: Effect of activated charcoal on yield parameters of parthenocarpic hybrid cucumber

Treatment	Number of female flower per plant	Average fruit weight (g)	Number of fruit per plant	No. Of fruit per plot	Fruit length (cm)	Fruit diameter (cm)
T0	45.67	181.08	36.33	18.58	15.12	4.35
T1	45.56	179.22	37.33	18.67	15.70	4.33
T2	45.39	181.73	37.33	17.57	15.53	4.25
T3	45.44	185.73	36.67	18.44	15.41	4.23
T4	45.19	186.43	35.33	19.08	16.39	4.35
T5	46.50	191.09	37.67	19.10	16.82	4.48
T6	45.33	197.41	35.67	18.19	15.91	4.38
T7	45.30	186.42	36.33	18.46	15.47	4.29
T8	45.45	189.48	37.33	18.50	15.63	4.23
T9	45.19	188.72	35.67	17.47	15.58	4.32
F test	S	S	S	S	S	S
S.E (d) (±)	0.17	0.22	0.71	0.20	0.22	0.03
CD 0.05	0.36	0.45	1.50	0.43	0.47	0.52
C.V	0.56	0.14	2.39	1.35	1.72	0.88

Table 5: Effect of activated charcoal on quality Parameters of parthenocarpic hybrid cucumber

Treatment	TSS(°Brix)	Vitamin C	Hardness
T0	4.60	1.27	6.07
T1	4.23	0.87	6.21

T2	4.20	1.20	6.32
T3	4.30	1.20	6.71
T4	4.67	1.20	6.69
T5	4.57	1.17	6.97
T6	4.70	1.20	6.90
T7	4.17	1.50	5.90
T8	4.60	1.20	5.71
T9	4.33	1.47	5.62
F test	S	S	S
S.E (d) (±)	0.10	0.07	0.06
CD 0.05	0.20	0.14	0.13
C.V	2.68	6.77	1.18

3.4 Quality Parameters

3.4.1 TSS (°Brix), vitamin C, Hardness and dry matter content

The effect of organic manures upon fruit quality characteristics like TSS (°Brix), ascorbic acid(mg/100 ml juice) and Hardness and dry matter content were recorded significant with activated charcoal application in parthenocarpic hybrid cucumber during investigation (Table 2 & 3). TSS (°Brix) was maximum in treatment T6 (6 g activated charcoal/ plant) at 4.70°Brix, followed closely by treatment T4(4 g activated charcoal) at 4.67°Brix, and the lowest in treatment T7(7 g activated charcoal/ plant) at 4.17 °Brix. The degrees Brix express the concentration of total soluble solids (sugars and organic acids), making it an important quality index.

The maximum Ascorbic acid mg/100g recorded in T7 (7g activated charcoal/ plant) at 1.7, followed by T9(9 g activated charcoal/plant) at 1.4 . The lowest Ascorbic acid mg/100g was found with T1(1g activated charcoal/ plant) at 0.87 . Generally, high ascorbic acid content would increase the nutritive value of cucumbers, which would help better retention of colour and flavor.The results of fruit hardness for parthenocarpic hybrid cucumber showed the highest value in T5 (5 g activated charcoal/ plant) at 6.97 and Followed by the Treatment-6 (6g activated charcoal / plant) at 6.90and Minimum was recorded in the Treatment-0 at 4.1 .

Dry matter content (in grams) was recorded maximum in the treatment T5 (5 g activatedcharcoal/ plant) at 5.88 grams, followed closely by the treatment T6(6g activated charcoal/plant) at 5.44 grams, and the lowest in the treatment T9 (9 g activated charcoal/ plant) at 4.21 grams.

The quality characteristics of parthenocarpic hybrid cucumber was significantly influence with the application of activated charcoal. Because it contains essential nutrients in accessible forms which escalates theplant growth by easily supplying to plant physiological activity. Thisimprovement in quality of fruits and enhances cell division and elongation, improve fruit quality.

3.5 Economic parameters

The Maximum Gross return was observed in the Treatment-5 (Rs.2,12,200) and Followed by the Treatment-4 (Rs. 2,10,200) and the Minimum was obtained in Treatment-9 (Rs.1,96,300).

The Maximum Net return was obtained in the Treatment-5 (Rs.1,68,428.68) and Followed bythe Treatment- 6 (Rs.1,66,628.68) the Minimum was obtained in Treatment-9 (Rs.1,52,728.68).

The Maximum Cost benefit ratio was recorded in theTreatment-5 (3.86) and Followed by the Treatment-4 (3.82) and Minimum was recorded in the Treatment-9 (3.50)

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4. Conclusion

The research revealed that activated charcoal had significant effect on Treatment-5 (5g activated charcoal per plant) which performed best in terms of growth parameters with maximum Vine length 136.39 cm, number of nodes 17.52, maximum chlorophyll content 57.68, shortest duration for flowering 31.30 days and fruit setting 33.41 days, maximum number of female flower per plant (46.50), fruits per plant (37.67), fruit length(16.82cm) , number of fruit yield per plot 19.10 kg, and dry matter content (5.88%). The highest benefit cost ratio was at 3.86 in the same treatment.

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