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Quality and yield of parthenocarpic cucumber (*Cucumis sativus* L.) under polyhouse condition as influenced by organic amendments

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Abstract
The rising demand for environmentally sustainable food production has heightened the significance of organic farming practices, particularly in the cultivation of high value crops such as cucumber. The study revealed that various treatment combinations of biodynamic, silica and *Dashparni* imparted significant effects on quality and yield parameters of cucumber var. Nagene grown under protected cultivation. An experiment was conducted during the Kharif season of 2023 under polyhouse at Hi-Tech Unit, Rajasthan College of Agriculture, which is situated in Udaipur using a completely randomized design with ten treatments combination of biodynamic, silica and *Dashparni*. Key parameters observed included moisture content, TSS content, chlorophyll α, chlorophyll *b*, total chlorophyll, yield per vine, yield per square meter and yield per acre of cucumber.
Out of various treatments and treatment combinations, treatment T_{10} (BD 500 @ 75 g/ha + BD 501 @ 2.5 g/ha + Silica @ 1% + *Dashparni* @ 10%) was found superior for TSS content (3.97%), yield per vine (4.20 kg), yield per square meter (10.07 kg) yield per acre (40.30 t) and T_6 *Dashparni* (10%) was found superior for chlorophyll α (3.44 mg/g), whereas least performing treatment was T_1 (control). No significant differences were observed in moisture content, chlorophyll *b* and total chlorophyll. The study concludes that phased application organic amendments, especially combining of biodynamic, silica and *Dashparni* can effectively enhance cucumber quality, yield and support sustainable organic agriculture under polyhouse condition.

Keywords: Cucumber, BD 500, BD 501, *Dashparni*, silica, biodynamic

Introduction
Cucumber (*Cucumis sativus* L.), a member of the family Cucurbitaceae, is a warm-season vegetable cultivated globally under tropical and subtropical conditions. Cucumber is one of the fastest maturing vine vegetables and is extensively grown across the country. The immature fruits are recognized for their cooling properties and are traditionally used to alleviate constipation and indigestion. Due to their early fruiting potential and profitability, cucumbers are particularly favored in protected cultivation systems such as polyhouses (Rajawat *et al.*, 2021) [18].
Given the urgent need to enhance vegetable production to meet the nutritional demands of a growing population, improving crop productivity has become a priority. With limited availability of cultivable land, the focus has shifted towards optimizing vertical space utilization, particularly through vertical farming practices (Ameta *et al.*, 2019) [2]. The adoption of parthenocarpic and gynoecious cucumber cultivars in controlled environments has shown promise in enhancing fruit yield and harvest index. These cultivars allow for more efficient use of limited growing areas, especially in protected cultivation systems (Meena *et al.*, 2017) [15].
Although chemical fertilizers have significantly contributed to intensive crop production and played a vital role in India's Green Revolution, their indiscriminate and imbalanced use has led to several adverse effects including nutrient imbalances, soil degradation and declining crop sustainability (Dhakar *et al.*, 2023) [6]. To address these challenges, organic inputs such as biodynamic preparations, silicon supplements and natural formulations like *Dashparni* Ark are gaining importance.

These inputs improve soil fertility, enhance plant resilience against biotic, abiotic stresses and function as eco-friendly pest management tools.

Among biodynamic inputs, BD 500 and BD 501 are particularly noteworthy. BD 500 enhances soil microbial activity and nutrient availability, including trace elements, while BD 501 complements it by promoting photosynthetic efficiency and nutrient assimilation through foliar application. Silicon (Si), though not classified as an essential element, has demonstrated beneficial effects on numerous crops, including horticultural species (Cai and Qian, 1995) [5]. In cucumbers, the application of silicon (100 mg/L) has been reported to enhance chlorophyll content, RuBP carboxylase activity and both root fresh and dry weights in hydroponic systems (Adatia and Besford, 1986) [1]. Notably, silicon exhibits no known phytotoxic effects, even at higher concentrations (Ma and Yamaji, 2006) [14].

Dashparni Ark, a plant based natural pesticide, has been effectively used for managing pests and diseases while enhancing soil fertility. It also contributes to improved plant vigor and overall crop health, making it suitable for a wide range of agricultural applications (Ganvir, 2022) [9].

2. Methodology

2.1 Experimental Site and Climate

The experiment was conducted under polyhouse at Hi-Tech Unit, Rajasthan College of Agriculture, which is situated in Udaipur at 24°35'N latitude 74°42'E longitude at 585.5 meters above mean sea level. Cucumber var. Nagene cultivated during July-October, 2023 in *Kharif* season. The polyhouse was covered with aluminate sheet and ultra violet stabilized low density polyethylene sheet having 200-micron thickness with provision of foggers.

2.2 Experimental Design and Treatments

The trial was laid out in Completely Randomized Design with three replications. The experiment was comprised of ten treatments comprising different combinations of organic sources such as biodynamic, silica and *Dashparni* for polyhouse cultivation of cucumber.

Table 1: Treatment details

S. No.	Treatment	Treatment combinations
	T_1	Control
	T_2	BD 500 (75 g/ha)
	T_3	BD 501 (2.5 g/ha)
	T_4	BD 500 (75 g/ha) + BD 501 (2.5 g/ha)
	T_5	Silica (1%)
	T_6	*Dashparni* (10%)
	T_7	Silica (1%) + *Dashparni* (10%)
	T_8	BD 500 (75 g/ha) + Silica (1%) + *Dashparni* (10%)
	T_9	BD 501 (2.5 g/ha) + Silica (1%) + *Dashparni* (10%)
	T_{10}	BD 500 (75 g/ha) + BD 501 (2.5 g/ha) + Silica (1%) + *Dashparni* (10%)

2.3 Crop and Cultural Practices

The cucumber var. Nagene seeds were sown in raised beds of 1 meter width and 45 cm above from ground level along with a spacing of 50 cm × 50 cm and length of polyhouse were prepared. Basal dose of FYM was applied and mixed in the soil one week before sowing. Spray of BD 500 in soil was done before 1 day of sowing in evening hours. Seeds were sown at approximately 2 cm depth. Foliar spray of BD 501, silica and *Dashparni* was done at 21, 42 and 63 DAS. All the cultural practices including irrigation and hoeing were carried out as per the standard commercial procedures. Plants were vertically trained with nylon ropes.

2.4 Observations recorded

2.4.1 Quality Parameters

2.4.1.1 Moisture content (%)

Fresh weight of individual fruit was taken from each treatment and replication and then dried in oven at 60 °C till constant weight was obtained for determining the moisture content. The moisture content in fruit was recorded and average was calculated by using the following formula:

$$\text{Moisture Content (g)} = \frac{\text{Fresh weight (g)-Dry weight (g)}}{\text{Fresh weight (g)}} \times 100$$

2.4.1.2 Total soluble solids (%)

Total soluble solids (TSS) of five marketable fruits from all the five tagged treatment and replication was determined with the help of hand refractometer. The values were corrected at 20 °C and average TSS content in fruits was expressed in percent as per standard procedure (A.O.A.C., 1990) [3].

2.4.1.3 Chlorophyll content of leaves (mg/g)

Chlorophyll content of fully matured 4th leaves from the bottom of randomly selected five plants of each treatment in all the replication was measured as per method suggested by Sadasivam and Manickam, (1997) [20]. The details of procedure followed are:

Requirements: Acetone, pestle mortar, centrifuge machine, spectrophotometer, measuring cylinder, beaker, centrifuge tubes and balance etc.

Reagents: 80% percent Acetone: 80 ml Acetone + 20 ml distilled water.

Method: Homogenize 200 mg fresh leaf tissue in 5 ml of 80 percent acetone and centrifuge at 5000 rpm for 20 minutes. Collect the supernatant and re-extract the residue with 5 ml of 80 percent acetone twice. After centrifugation mix all the supernatants and make the volume to 20 ml with 80 percent acetone. Measure optical density (O.D.) at 645 nm and 663 nm using the 80 percent acetone as blank. The chlorophyll content was calculated and expressed as mg/g fresh weight using formula as follows:

2.4.1.4 Chlorophyll α content of leaves (mg/g)

$$\text{Chlorophyll } \alpha = \frac{[12.7 \times \text{OD(A663)} - 2.69 \times \text{OD(A645)}] \times \text{V}}{1000 \times \text{W}}$$

2.4.1.5 Chlorophyll b content of leaves (mg/g)

$$\text{Chlorophyll } b = \frac{[22.9 \times \text{OD(A645)} - 4.68 \times \text{OD(A663)}] \times \text{V}}{1000 \times \text{W}}$$

2.4.1.6 Total chlorophyll content of leaves (mg/g)

$$\text{Total Chlorophyll} = \frac{[20.2 \times \text{OD(A645)} + 8.02 \times \text{OD(A663)}] \times \text{V}}{1000 \times \text{W}}$$

2.4.2 Yield Parameters

2.4.2.1 Yield per vine (kg)

Yield per vine was derived by multiplication of number of fruits per vine and average weight of fruit in each treatment and replication and expressed in kilograms.

2.4.2.2 Yield per square meter (kg)

The yield per square meter was calculated by multiplying total yield per vine with number of plants accommodated in one square meter area *i.e*. 2.22 and expressed in kilograms.

2.4.2.3 Yield per acre (t)

The yield per acre was calculated by multiplying yield per square meter with 4000 and divided by 1000 and expressed in tons.

2.5 Statistical analysis

Data were analyzed using analysis of variance (ANOVA) appropriate for RBD as per the method suggested by Panse and Sukhatme (1989) [16]. Treatment means were compared using the critical difference (CD) at 5% level of significance.

3. Results and Discussion

3.1 Quality parameters

Analysed data on moisture content, TSS, chlorophyll α content of leaf, chlorophyll *b* content of leaf and total chlorophyll content of leaf as influenced by different treatments under polyhouse conditions are presented in Table-2. Results showed that only two quality parameters *viz*., TSS (%) and chlorophyll α content of leaves (mg/g) differed significantly with the application of treatments, whereas moisture content (%), chlorophyll *b* content of leaves (mg/g) and total chlorophyll content of leaves (mg/g) showed non-significant difference.

The results revealed that highest value of TSS was recorded for treatment T_{10} (BD 500 @ 75 g/ha + BD 501 @ 2.5 g/ha + Silica @ 1% + *Dashparni* @ 10%), which may be due to balanced nutrition through organic amendments as same trends of findings has been seen by Ram *et al.* (2019) in mango, who reported maximum TSS (24.93 ^{0}Brix) from application of treatment T_2 having [Biodynamic compost (30 kg/tree) + bio-enhancers cow pat pit (CPP)-100 g, BD-500 and BD-501] as soil and foliar spray. Similar findings have been reported by Hanumanthaiah *et al.* (2015) [12], who reported significant difference in the total soluble solids with soil and foliar application of silicon on banana cv. Elakkibale, further, silicon helps in synthesis of more sugars in the fruit and thus helped in increasing total soluble solids, this finding was in accordance to results of Bhavya (2010) [4] while working with grapes cv Bangalore Blue.

Out of three parameters of chlorophyll *viz* chlorophyll α, Chlorophyll *b* and total chlorophyll, only chlorophyll α was significantly affected with various treatments with maximum value reported for treatment T_6 (*Dashparni* @ 10%), it might be due to pesticidal properties of *Dashparni*, which protects foliage from insect, pest and diseases, hence healthy leaves with more chlorophyll were observed in this treatment. Findings of Vasant *et al.* (2010) [22] was in agreement with present findings as they observed highly inhibitory effect of *Dashparni* extract to the powdery mildew of melons.

3.2 Yield parameters

Yield per vine, yield per square meter and yield per acre of cucumber presented in Table-2 which are most important and economic traits also significantly varied with application various treatments. Significantly utmost yield per vine (4.20 kg), yield per square meter (10.07 kg) and yield per acre (40.30 t) were recorded in treatment T_{10} (BD 500 @ 75 g/ha + BD 501 @ 2.5 g/ha + Silica @ 1% + *Dashparni* @ 10%) followed by (3.93 kg) treatment T_9 (BD 501 @ 2.5 g/ha + Silica @ 1% + *Dashparni* @ 10%), whereas least performing treatment was treatment T_1 (Control) by producing minimum yield per vine (3.27 kg), yield per square meter (7.83 kg) and yield per acre (31.33 t). Yield increased due to application of Biodynamic compost and silica has been seen by various researchers in different crops. Highest yield due to application of BD 500 and BD 501 has been reported by Sharma *et al.* (2012) [10] while working with cumin, Jariene *et al.* (2014) [13] while working with potato, whereas maximum yield was reported due to application of BD 501 in potato (Gaware *et al.*, 2022) [10]. Application of Biodynamic provided the nutrients to the crop for its proper growth and development with the culmination of higher yield reported by Dutta *et al.* (2018) [7].

Table 2: Effect of organic amendments on yield and quality traits of cucumber.

T. No.	Treatment details	Moisture content (%)	TSS (%)	Chlorophyll α (mg/g)	Chlorophyll *b* (mg/g)	Total Chlorophyll (mg/g)	Yield/ vine (kg)	Yield/ m^2 (kg)	Yield/ acre (t)
T_1	Control	94.10	3.43	3.23	1.29	4.52	3.27	7.83	31.33
T_2	BD 500 (75 g/ha)	94.57	3.63	2.93	2.00	4.93	3.40	8.13	32.57
T_3	BD 501 (2.5 g/ha)	94.70	3.63	3.25	1.70	4.95	3.67	8.90	35.60
T_4	BD 500 (75g/ha) + BD 501 (2.5 g/ha)	94.80	3.80	3.32	1.65	4.97	3.70	8.90	35.67
T_5	Silica (1%)	94.13	3.67	3.20	1.69	4.90	3.53	8.53	34.03
T_6	*Dashparni* (10%)	94.97	3.73	3.44	1.40	4.85	3.47	8.37	33.40
T_7	Silica (1%) + *Dashparni* (10%)	94.17	3.73	3.39	1.57	4.95	3.73	9.00	36.00
T_8	BD 500(75 g/ ha) + Silica (1%) + *Dashparni* (10%)	94.10	3.90	3.16	1.76	4.93	3.93	9.50	37.90
T_9	BD 501(2.5 g/ha) + Silica (1%) + *Dashparni* (10%)	94.53	3.90	3.35	1.54	4.89	3.93	9.47	37.87
T_{10}	BD 500 (75 g/ha) + BD 501 (2.5 g/ha) + Silica (1%) + *Dashparni* (10%)	94.67	3.97	3.23	1.57	4.80	4.20	10.07	40.30
	SE(m)±	0.726	0.101	0.066	0.207	0.219	0.115	0.277	1.100
	C.D. (P=0.05)	NS	0.299	0.196	NS	NS	0.340	0.824	3.269

4. Conclusion

On the basis of results obtained in present investigation, it could be concluded that among the different treatments used, treatment T_{10} (BD 500 @ 75 g/ha + BD 501 @ 2.5 g/ha + Silica @ 1% + *Dashparni* @ 10%) proved the most beneficial for most of parameters studied *viz*., yield per vine, yield per square meter, yield per acre and TSS, while treatment T_6 (*Dashparni* @ 10%) was found superior for chlorophyll α. These organic amendments enhanced quality, yield and overall crop performance, thereby offering an organic cultivation for cucumber under polyhouse condition.

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