D-5985
[1-7]

RESEARCH ARTICLE Agricultural Science Digest, Volume Issue : ()

Assessment of Physiological and Qualitative Traits of Cucumber Genotypes under Ambient Conditions

Vishal Tripathi[1], Vijay Kumar Singh[2], Ajay Bhardwaj[2], Amrita Kumari[2], Etalesh Goutam[1] 10.18805/ag.D-5985

ABSTRACT

Background: With the advancement of storage period the crispness or firmness of greenhouse cucumber gradually decreased and usually had a shelf life counting from only 3 to 5 days at the ambient conditions.

Methods: This experiment was conducted to evaluate the status of quality deterioration during post-harvest handling of different genotypes of greenhouse cucumber under ambient conditions. The basis of evaluation was based on the analysis of several physiological and qualitative traits including, physiological loss in weight (%), firmness (Newton), total soluble solids (°Brix), titratable acidity (%), total chlorophyll and total carotenoid content (mg/100 mg fresh weight).

Result: Among cucumber inbred lines, the genotype, BRGCU-4 was observed with minimum moisture loss and highest firmness values, while the BRPCU-8 found to be best in retaining highest TSS and acidity and BRPCU-3 exhibited highest chlorophyll content during the storage period of a week. Moreover, hybrids of BRGCU-4 × BRPCU-6, followed by BRGCU-4 × BRPCU-8 were much better in retaining moistures and firmness, while the BRPCU-3 × BRPCU-6 hybrids recorded for highest chlorophyll andcarotenoid content. Therefore, these genotypes were found to be suitable for transportation, marketing and storage at ambient conditions.

Key words: Cucumber, Genotypes, Greenhouse, Postharvest, Quality.

INTRODUCTION

The polyhouse cucumber (*Cucumis sativus* L.) has a great demand in domestic as well as in foreign markets because it has its unique crispness, burpless and high-water containing capacity (Shabbir *et al.,* 2020; Amin *et al.,* 2021; Singh *et al.,* 2021). Cucumbers are referred to as "non-climacteric" fruits and harvested at an immature stage for fresh consumption as salad. Its seeds can also be used as antipyretic, diuretic and purgative (Sumita and Vivekananda, 2023). With the advancement of storage period, its crispness or firmness property gradually decreased as per loss in weight and lasts for only 3 to 5 days at the ambient conditions. Other quality traits like TSS, chlorophyll and carotenoid content would also be affected by these changes, but reports on these particulars are very skimpy. These cucumber fruits are also suffered from mechanical injuries during transportation, which resulted into their shorter shelf life and non-marketable quality. In the markets the shelf life of cucumber is maximally lasts up to 2-3 days. Being a chilling sensitive vegetable, they are not suggested to store at temperature below 7-10°C (Raghav and Saini, 2018). The marketability of this perishable fruit is irrevocably linked to the availability of appropriate technology that mitigates losses during storage.

Therefore, this research work was carried out to screen out the suitable genotypes and their appropriate crosses suitable to transportation, marketing and storage under ambient conditions without affecting their quality.

MATERIALS AND METHODS

This experiment was conducted in the laboratory of Department of Food Science and Postharvest Technology (FS and PHT), Bihar Agricultural University, Sabour, Bhagalpur during the year 2019-2020. Uniform size of fresh cucumber fruits from the second picking onwards were brought from the polyhouse complex of Department of Horticulture (Vegetable and Floriculture), Bihar Agricultural University, Sabour, Bhagalpur. Harvested fruits were stored at ambient conditions (temperature 24±2°C and relative humidity 60-80%) in laboratory for further analysis. The observations related to different physiological and qualitative traits including physiological loss in weight (%), total soluble solids (°Brix), firmness (N), titratable acidity (%), total chlorophyll and total carotenoid content (mg/100 g fresh weight) were recorded.

Physiological loss in weight (%)

The physiological loss in weight (PLW) was calculated by taking five cucumber fruits from each plant of each treatment

[1]Department of Horticulture, Lovely Professional University, Phagwara-144 411, Punjab, India.
[2]Department of Horticulture (Vegetable and Floriculture), Bihar Agricultural College, Bhagalpur-813 210, Bihar, India.

Corresponding Author: Vishal Tripathi, Department of Horticulture, Lovely Professional University, Phagwara-144 411, Punjab, India.
Email: vishal.ambro@gmail.com

How to cite this article: Tripathi, V., Singh, V.K., Bhardwaj, A., Kumari, A. and Goutam, E. (2024). Assessment of Physiological and Qualitative Traits of Cucumber Genotypes under Ambient Conditions. Agricultural Science Digest. DOI: 10.18805/ag.D-5985.

Submitted: 01-03-2024 **Accepted:** 10-06-2024 **Online:** 24-07-2024

and weighed starting from the first day of a storage to the end of a period of seven days or a week. The results were expressed as the percentage loss of initial weight using the following formula;

$$\text{PLW (\%)} = \frac{\text{Intial weight - Final weight}}{\text{Intial weight}} \times 100$$

Total soluble solids (°Brix)

Total soluble solids content of randomly chosen fruits from each replication and treatment was determined using digital refractometer (Atago, Tokyo, Japan) at room temperature and their average was worked out.

Firmness (N)

Firmness of the cucumber fruits were measured using an FTC's TMS-Pilot Texture Analyzer machine. A cylindrical probe with diameter of 5mm was used to puncture at distal, middle and blossom end of selected fruit to a depth of 5 mm and the mean value was calculated and reading on the machine was noted in Newton.

Titratable acidity (%)

Titratable acidity (TA) was measured using the method described by Rangana (1977). 5 g sample of each cucumber fruit was taken and homogenized with 50ml of distilled water using a kitchen blender. The mixture was filtered using a filter paper and 10 ml of the filtrate was pipetted and titrated to the end-point of phenolphthalein against 0.1 N NaOH. Then results were expressed in percentage (grams of citric acid equivalent per 100 g of cucumber) using the following formula:

$$\text{TA (\%)} = \frac{\text{Titre value} \times \text{Normality of alkali} \times \text{Vol. made up} \times \text{Eq. wt. of acid}}{\text{Vol. of aliquot} \times \text{wt. of sample} \times 1000} \times 100$$

Total chlorophyll content (mg/100 mg of fresh weight)

The chlorophyll content was calculated by the methodology suggested by Lichtenhaler and Buschmann (2001) following the equation;

Total chlorophyll content (mg/100 mg of fresh weight) =

$$\left(\frac{a}{\text{Fresh weight (g)}}\right) + \left(\frac{b}{\text{Fresh weight (g)}} \times \text{SPAD value}\right)$$

Where:
a and b= Were the constants.

Total carotenoid content (mg/100 g fresh weight)

Carotenoids were extracted by taking one gram of cucumber peel and cut into pieces. 9 ml of 80% acetone solution was added into the test tube containing fine pieces of cucumber peel and then samples were kept for 48 hours under dark conditions. The absorbance of the supernatant at 663.2 nm, 646.8 nm and 452.5 nm was determined using spectrophotometer against a blank reagent.

Statistical analysis

The collected data sets were statistically analyzed through Duncan's multiple range test (DMRT) at 1% (P<0.01) level of significance.

RESULTS AND DISCUSSION

The analyzed data as stated in the Table 1, it was observed that PLW (%) of cucumber fruits increased progressively with the advancement of storage periods and it was found out to be statistically significant (P<0.01) among all treatments (including parents, hybrids and check). Among parents, BRGCU-4 exhibited the lowest PLW% ranging from 2.53 to 8.64 from 1st to 7th day of storage (Table 1), which was significantly superior to rest of the parental lines taken under investigation. In hybrids, cross of BRGCU-4 × BRPCU-6 showed the minimum PLW as 10.90%, followed by BRGCU-4 × BRPCU-8 as 11.33%. The rapidly loss of weight of fresh fruits may be due to lower level of relative humidity (RH) at ambient condition. These results were in agreement with Manjunatha and Anurag (2014), Omoba and Onyekwere (2016), Jia *et al.* (2018) and Raghav and Saini (2018) in cucumber.

The total soluble solids (°Brix) of fruits were measured at the first, 4th and 7th day of storage period (Table 2) and it was found out to be statistically significant (P<0.01) for all treatments (including parents, hybrids and check). At ambient conditions, the TSS of cucumber fruits showed a gradual decrease. Being a basic constituent of TSS, sugar was used in respiration for metabolic activities of fruits and vegetables (Ozden and Bayindirli, 2002; Raghav and Saini, 2018), therefore reduction in TSS content was recorded. The parental lines BRPCU-7 and BRPCU-8 and hybrids of BRPCU-3 × BRPCU-7 and BRPCU-2 × BRPCU-8 were found significantly superior as they showed highest TSS during storage period. This result was in agreement with the findings of Jia *et al.* (2018) in cucumber.

The results of firmness of all cucumber fruits stored at ambient conditions for a period of week decreased sharply (Table 2) and all the treatments were found out to be significantly different (P<0.01). The parent BRGCU-4 showed significantly highest value of firmness during storage periods, while crosses BRGCU-4 × BRPCU-6, BRGCU-4 × BRPCU-5, BRGCU-4 × BRPCU-7 and BRGCU-4 × BRPCU-8 exhibited highest firmness but with non-significant differences from each other. The loss of firmness of fruits is a biochemical process that involved enzymatic hydrolysis of pectin and starch (Raghav and Saini, 2018), or it was caused by composition of cell wall, deterioration of cell structure and intracellular membrane Seymour *et al.* (1993), Dhall and Sharma (2012), Moalemiyan and Ramaswamy (2012), Manjunatha and Anurag (2014), Omoba and Onyekwere (2016), Jia *et al.* (2018) and Raghav and Saini (2018).

The titratable acidity has shown a statistically significant (P<0.01%) difference among all the treatments (including parents, check and hybrids). The percentage value of titratable acidity was found out to be on slightly higher side and observed with decreasing *vis-a-vis* stable trends during first four days of storage, but reducing trends were seen from day 4 to 7 (Table 2). The highest acidity was recorded in parents BRPCU-2 and BRPCU-8, while the hybrids of crosses BRPCU-3 × BRPCU-6 and BRPCU-1 × BRPCU-8 were reported with significantly higher acidity during storage. Organic acids like malic and citric acids are the basic substrate of respiration and decrement of acidity with storage is useful as it renders the fruits less sour and acidic (Raghav and Saini, 2018). Similar results were reported by Omoba and Onyekwere (2016) in cucumber.

The analyzed results of the level of chlorophyll contents and carotenoids are being described in the Table 3. These

Table 1: Assessment of physiological loss in weight (%) of fruits of different cucumber genotypes from 1st to 7th day of post-harvest storage.

Genotypes	Physiological loss in weight (%)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
BRPCU-1 × BRPCU-2	3.51^{cbd}	5.23^{lmkj}	7.06^{kj}	9.43^{ighj}	10.65^{gf}	12.63^{gh}	14.12^{ghi}
BRPCU-1 × BRPCU-3	4.33^{a}	5.84^{cebd}	7.27^{hij}	9.85^{fgde}	10.50^{gh}	11.41^{j}	13.94^{jhi}
BRPCU-1 × BRGCU-4	3.22^{ed}	4.94^{mon}	6.80^{k}	7.56^{l}	8.86^{l}	9.21^{p}	12.40^{m}
BRPCU-1 × BRPCU-5	3.16^{fe}	5.72^{cefd}	7.47^{hig}	9.03^{j}	10.28^{jhi}	12.54^{gih}	14.02^{hi}
BRPCU-1 × BRPCU-6	3.27^{ed}	5.02^{lmn}	6.43^{l}	8.39^{k}	9.58^{k}	13.11^{dfe}	15.39^{de}
BRPCU-1 × BRPCU-7	3.01^{ifhegj}	4.68^{poq}	6.24^{ml}	7.72^{l}	9.48^{k}	10.95^{k}	13.07^{kl}
BRPCU-1 × BRPCU-8	3.10^{fheg}	6.00^{cb}	8.87^{b}	10.40^{cb}	11.73^{c}	13.64^{c}	15.56^{dc}
BRPCU-2 × BRPCU-3	4.22^{a}	6.11^{b}	7.58^{hgf}	9.65^{fghe}	11.41^{dce}	12.11^{i}	14.40^{ghf}
BRPCU-2 × BRGCU-4	2.70^{ikj}	4.58^{prq}	5.91^{mn}	6.83^{m}	8.37^{m}	9.78^{o}	12.85^{ml}
BRPCU-2 × BRPCU-5	3.15^{fe}	5.83^{cebd}	7.89^{edf}	10.60^{b}	12.33^{b}	13.62^{c}	15.18^{de}
BRPCU-2 × BRPCU-6	3.26^{ed}	5.31^{lkji}	7.24^{hij}	8.36^{k}	10.47^{gh}	12.62^{gh}	14.14^{ghi}
BRPCU-2 × BRPCU-7	2.75^{ihkj}	5.64^{hgefd}	6.90^{kj}	7.72^{l}	9.09^{l}	10.79^{lk}	13.55^{jki}
BRPCU-2 × BRPCU-8	3.33^{ced}	5.75^{cefd}	9.63^{a}	11.25^{a}	13.71^{a}	15.12^{a}	16.01^{bc}
BRPCU-3 × BRGCU-4	3.31^{ced}	4.17st	6.15^{ml}	7.68^{l}	8.78^{l}	10.29^{nm}	11.67^{n}
BRPCU-3 × BRPCU-5	3.23^{ed}	5.52^{hgefji}	7.67^{egf}	9.58^{fgh}	11.70^{dc}	13.58^{c}	15.00^{def}
BRPCU-3 × BRPCU-6	3.01^{ifhegj}	5.07^{lmkn}	7.20^{ij}	8.22^{k}	10.03^{j}	11.55^{j}	12.84^{ml}
BRPCU-3 × BRPCU-7	3.03^{ifheg}	4.50^{rq}	6.92^{kj}	9.13^{ij}	10.51^{gh}	13.70^{c}	14.86^{ef}
BRPCU-3 × BRPCU- 8	3.53^{cbd}	5.55^{hgefdi}	6.08^{ml}	8.32^{k}	10.13^{ji}	11.44^{j}	12.72^{ml}
BRGCU-4 × BRPCU-5	2.67^{kj}	4.87^{pon}	5.67^{on}	7.57^{l}	8.25^{m}	9.58^{op}	12.30^{m}
BRGCU-4 × BRPCU-6	2.78^{ihkgj}	4.61^{prq}	5.62^{on}	7.67^{l}	8.35^{m}	9.91^{on}	10.90^{o}
BRGCU-4 × BRPCU-7	2.76^{ihkj}	4.12st	5.88^{mn}	6.90^{m}	8.96^{l}	10.43^{lm}	12.43^{m}
BRGCU-4 × BRPCU-8	2.77^{ihkj}	4.37^{sr}	5.53^{o}	6.76^{m}	8.09^{m}	9.26^{p}	11.33^{on}
BRPCU-5 × BRPCU-6	3.63^{cb}	5.57^{hgefdi}	7.66^{egf}	10.20^{cd}	12.27^{b}	13.33^{dce}	14.48^{ghf}
BRPCU-5 × BRPCU-7	3.57^{cbd}	6.64^{a}	7.88^{edf}	9.53^{fgh}	10.61^{gf}	12.42^{ih}	13.70^{jki}
BRPCU-5 × BRPCU-8	2.87^{ifhkgj}	5.66^{gefd}	7.73^{egf}	9.10^{ij}	11.29^{e}	12.49^{ih}	13.86^{jhi}
BRPCU-6 × BRPCU-7	3.52^{cbd}	4.92^{on}	6.41^{l}	8.51^{k}	10.40^{ghi}	11.53^{j}	13.33^{jkl}
BRPCU-6 × BRPCU-8	3.09^{fheg}	5.87^{cbd}	7.51^{higf}	9.63^{fghe}	11.30^{e}	12.66^{gfh}	14.15^{ghi}
BRPCU-7 × BRPCU-8	3.34^{ced}	5.50^{hgfji}	7.16^{kij}	9.68^{fghe}	11.39d^{e}	13.64^{c}	14.76^{gef}
RS-03602833 (Check)	4.42^{a}	6.46^{a}	8.53^{c}	11.28^{a}	13.78^{a}	15.50^{a}	16.27^{ba}
BRPCU-1	3.01^{ifhegj}	5.73^{cefd}	7.02^{kj}	9.69^{fghe}	11.39^{de}	12.84^{gfh}	13.91^{jhi}
BRPCU- 2	3.76^{b}	5.33^{hkji}	6.09^{ml}	7.53^{l}	8.32^{m}	10.55^{lkm}	13.20^{kl}
BRPCU-3	3.01^{ifhegj}	5.38^{hgji}	7.61^{hgf}	9.47^{igh}	10.85^{f}	12.37^{ih}	14.42^{ghf}
BRGCU-4	2.53^{k}	4.04^{t}	4.23^{p}	5.66^{n}	6.38^{n}	6.92^{q}	8.64^{p}
BRPCU-5	3.32^{ced}	6.55^{a}	7.98^{ed}	9.36^{ihj}	11.25^{e}	12.99^{gfe}	15.31^{de}
BRPCU-6	4.13^{a}	5.83^{cebd}	7.46^{hig}	10.04^{cde}	11.53^{dce}	13.64^{c}	14.75^{gef}
BRPCU-7	4.16^{a}	5.87^{cbd}	8.12^{d}	9.94^{fde}	12.46^{b}	14.32^{b}	16.66^{a}
BRPCU-8	3.13^{feg}	5.61^{hgefdi}	7.58^{hgf}	9.56^{fgh}	10.66g^{f}	13.54^{dc}	15.01^{def}
CD	0.288	0.272	0.326	0.354	0.264	0.418	0.572
SEM (±)	0.102	0.096	0.115	0.125	0.094	0.148	0.178
CV	5.510	3.107	2.832	2.450	1.655	2.128	2.547

Values marked with same letter (s) are not significantly different as per DMRT at 1% level of significance.

are the bio functionally important compounds that preserved both quality and attractiveness of fruits during storage. The highest amount of total chlorophyll was observed in the parents BRPCU-6 and BRPCU- 7, but at the end of the storage period, parent BRPCU-3 was reported with significantly higher amount of total chlorophyll. While, in case of hybrids, cross of BRPCU-3 × BRPCU-6 exhibited the minimum loss in chlorophyll content and exhibited significantly superior values than remaining hybrids during storage periods. The amount of chlorophyll a, b and total chlorophyll showed the decreasing pattern during storage periods. Similar trends were also reported by Nilsson (2005),

Table 2: Evaluation of TSS (°Brix), firmness (N) and titratable acidity (%) of fruits of different cucumber genotypes on first, 4th and 7th day of post-harvest storage.

Genotypes	TSS (°Brix)			Firmness (N)			Titratable acidity (%)		
	Day 0	Day 4	Day 7	Day 0	Day 4	Day 7	Day 0	Day 4	Day 7
BRPCU-1 × BRPCU-2	$3.40^{imklhjg}$	3.33^{fgecd}	3.16^{ifgeh}	37.27^{r}	32.69^{p}	31.40^{qrs}	0.20^{jgifh}	0.21^{ef}	0.19^{fehdg}
BRPCU-1 × BRPCU-3	3.30^{noml}	3.13^{ijh}	2.93^{iljk}	38.38^{r}	35.18^{o}	32.00^{qprs}	0.24^{b}	0.24^{bac}	0.20^{1b}
BRPCU-1 × BRGCU-4	3.27^{nom}	3.07^{ij}	3.00^{iljhk}	41.41^{qpo}	38.73^{jlmk}	36.87^{hi}	0.20^{gifh}	0.19^{jmikl}	0.17^{lonm}
BRPCU-1 × BRPCU-5	$3.50^{fiedhcg}$	3.37^{fbecd}	3.17^{fgeh}	42.84^{monl}	38.49^{jlmk}	36.53^{hij}	0.21^{gefh}	0.21^{hfg}	0.20^{fcebdg}
BRPCU-1 × BRPCU-6	3.33^{nmkl}	3.00^{kj}	2.93^{iljk}	45.52^{gfh}	38.98^{jlk}	36.92^{hi}	0.21^{gefd}	0.21^{fg}	0.18^{likhjg}
BRPCU-1 × BRPCU-7	3.20^{op}	2.83^{l}	2.85^{ljk}	42.33^{mpon}	38.99^{jlk}	32.19^{qoprs}	0.16^{op}	0.17^{mn}	0.15^{oqrp}
BRPCU-1 × BRPCU-8	3.60^{bdc}	3.13^{ijh}	2.97^{iljhk}	49.61^{e}	42.52^{g}	38.85^{g}	0.20^{jgikh}	0.25^{ba}	0.23^{a}
BRPCU-2 × BRPCU-3	3.38^{imklhj}	3.28^{fgedh}	3.02^{ilgjhk}	43.70^{jmikl}	38.73^{jlmk}	32.45^{qoprs}	0.20^{jgifh}	0.17^{no}	0.15^{qrp}
BRPCU-2 × BRGCU-4	3.23^{no}	3.17^{gijh}	3.15^{ifgeh}	46.58^{f}	42.80^{g}	38.97^{g}	0.17^{onpm}	0.17^{no}	0.13^{r}
BRPCU-2 × BRPCU-5	$3.40^{imklhjg}$	3.23^{fgeih}	3.05^{ifgjhk}	44.79^{jgikh}	42.65^{g}	38.97^{g}	0.22^{cebd}	0.23^{bdc}	0.21^{cbd}
BRPCU-2 × BRPCU-6	3.37^{nimklj}	3.30^{fgecdh}	3.17^{ifgeh}	43.57^{jmkl}	39.61^{jik}	33.39^{opmn}	0.17^{onp}	0.17^{mn}	0.15^{oqnp}
BRPCU-2 × BRPCU-7	$3.52^{fbedhcg}$	3.40^{becd}	3.25^{fgeh}	44.48^{jgikhl}	41.87^{hg}	36.90^{hi}	0.18^{jlnkm}	0.18^{mnl}	0.15^{oqnp}
BRPCU-2 × BRPCU-8	3.89^{a}	3.74^{a}	3.52^{b}	45.16^{jgifh}	43.20^{g}	34.85^{klmj}	0.19^{jlikh}	0.18^{jmkl}	0.16^{lonpm}
BRPCU-3 × BRGCU-4	$3.42^{fiklhjg}$	3.35^{fbecd}	3.16^{ifgeh}	57.49^{d}	55.34^{e}	52.22^{e}	0.17^{onp}	0.21^{efg}	0.20^{fcebd}
BRPCU-3 × BRPCU-5	3.35^{nmklj}	3.20^{fgih}	3.25^{fged}	46.19^{gf}	43.50^{g}	38.67^{g}	0.23^{cb}	0.24^{bdc}	0.21^{cb}
BRPCU-3 × BRPCU-6	3.25^{no}	3.07^{ij}	2.89^{ljk}	43.57^{jmkl}	38.35^{jlmk}	35.82^{kij}	0.26^{a}	0.25^{a}	0.24^{a}
BRPCU-3 × BRPCU-7	3.98^{a}	3.86^{a}	3.73^{a}	41.48^{qpo}	39.41^{jik}	35.81^{kij}	0.16^{p}	0.18^{mnkl}	0.17^{likhjm}
BRPCU-3 × BRPCU- 8	3.56^{bedc}	3.47^{bc}	3.07^{ifgjhk}	49.09^{e}	46.37^{f}	43.33^{f}	0.17^{onpm}	0.20^{hifg}	0.20^{fcebd}
BRGCU-4 × BRPCU-5	3.63^{bc}	3.52^{b}	2.83^{l}	64.93^{c}	63.59^{b}	58.95^{c}	0.17^{onp}	0.19^{jmikl}	0.17^{lknjm}
BRGCU-4 × BRPCU-6	3.53^{fedcg}	3.42^{bcd}	3.25^{fgeh}	66.82^{b}	64.39^{b}	62.97^{b}	0.18^{jlnkm}	0.19^{jmikl}	0.16^{loqnpm}
BRGCU-4 × BRPCU-7	$3.45^{fiekhjg}$	3.35^{fbecd}	3.16^{ifgeh}	64.45^{c}	58.90^{d}	54.97^{d}	0.20^{jgih}	0.20^{jhikg}	0.17^{lknjm}
BRGCU-4 × BRPCU-8	$3.40^{imklhjg}$	3.13^{ijh}	2.85^{ljk}	63.85^{c}	61.73^{c}	59.36^{c}	0.20^{jgikh}	0.20^{hifg}	0.19^{fiehjg}
BRPCU-5 × BRPCU-6	3.27^{nom}	3.00^{kj}	2.84^{lk}	43.46^{jmknl}	39.11^{jlik}	33.32^{opmn}	0.16^{p}	0.19^{jhikl}	0.17^{likjm}
BRPCU-5 × BRPCU-7	$3.48^{fiedhjg}$	3.42^{bcd}	3.21^{fgeh}	41.36^{qpo}	37.15^{nm}	32.90^{qoprn}	0.16^{op}	0.20^{jhifg}	0.19^{fikhjg}
BRPCU-5 × BRPCU-8	3.55^{fedc}	3.40^{becd}	3.07^{ifgjh}	41.07^{qpo}	38.60^{jlmk}	35.95^{kij}	0.17^{olnpm}	0.20^{hifg}	0.19^{fcedg}
BRPCU-6 × BRPCU-7	$3.47^{fiekdhjg}$	3.23^{fgeih}	3.16^{ifgeh}	40.73^{qp}	35.97^{no}	32.85^{qoprn}	0.19^{jlikm}	0.19^{jhikl}	0.17^{loknm}
BRPCU-6 × BRPCU-8	$3.50^{fiedhcg}$	3.35^{fbecd}	3.06^{ifgjhk}	41.73^{qpon}	38.28^{lmk}	33.91^{olmn}	0.19^{jlikm}	0.18^{mnl}	0.15^{qr}
BRPCU-7 × BRPCU-8	$3.50^{fiedhcg}$	3.47^{bc}	3.35^{ced}	45.59^{gfh}	40.75^{hi}	38.03^{hg}	0.19^{jlikh}	0.23^{dc}	0.17^{loknm}
RS-03602833 (Check)	$3.40^{imklhjg}$	3.23^{fgeih}	3.17^{ifgeh}	41.45^{qpo}	37.47^{nlm}	33.15^{qopmn}	0.21^{gefh}	0.21^{ef}	0.19^{fiehg}
BRPCU-1	3.10^{p}	2.94^{k}	2.85^{ljk}	40.73^{qp}	36.45^{no}	33.47^{opmn}	0.19^{jlikm}	0.19^{jmikl}	0.16^{oqnpm}
BRPCU- 2	3.35^{nmklj}	3.25^{fgedh}	3.18^{fgeh}	43.24^{mknl}	40.09^{ji}	34.47^{klmn}	0.23^{cbd}	0.23^{ed}	0.21^{cebd}
BRPCU-3	$3.42^{fiklhjg}$	3.17^{gijh}	2.97^{iljhk}	45.43^{gifh}	43.00^{g}	35.42^{klij}	0.21^{gef}	0.21^{hfg}	0.19^{fcedg}
BRGCU-4	$3.48^{fiedhjg}$	3.30^{fgecdh}	2.98^{iljhk}	69.97^{a}	68.05^{a}	66.06^{a}	0.18^{olnkm}	0.17^{mn}	0.17^{lonm}
BRPCU-5	3.57^{edc}	3.42^{bcd}	3.18^{fgeh}	41.75^{qpon}	39.17^{jlik}	30.76^{s}	0.21^{gef}	0.20^{hifg}	0.19^{fikhjg}
BRPCU-6	$3.40^{imklhjg}$	3.37^{fbecd}	3.27^{fed}	40.06^{q}	36.37^{no}	31.16^{rs}	0.16^{p}	0.16^{o}	0.13^{r}
BRPCU-7	3.65^{b}	3.47^{bc}	3.35^{ced}	44.24^{jikhl}	39.44^{jik}	30.97^{s}	0.17^{onpm}	0.18^{jmkl}	0.17^{loknm}
BRPCU-8	3.63^{bc}	3.42^{bcd}	3.26^{fed}	43.55^{jmkl}	39.44^{jik}	35.50^{klij}	0.22^{cefd}	0.21^{ef}	0.19^{fcedg}
CD	0.112	0.145	0.196	1.540	1.495	1.606	0.016	0.014	0.016
SEM (±)	0.040	0.051	0.069	0.545	0.529	0.568	0.006	0.005	0.006
CV	1.986	2.719	3.752	2.021	2.126	2.529	4.962	4.175	4.962

Values marked with same letter (s) are not significantly different as per DMRT at 1% level of significance.

Table 3: Estimation of chlorophyll a, b, total chlorophyll and total carotenoid content (mg/100 mg FW) of fruits of different cucumber genotypes on 1st, 4th and 7th day of post-harvest storage.

Genotypes	Chlorophyll a (mg/100 mg FW)			Chlorophyll b (mg/100 mg FW)			Total chlorophyll (mg/100 mg FW)			Total carotenoid (mg/100 mg FW)		
	Day 0	Day 4	Day 7	Day 0	Day 4	Day 7	Day 0	Day 4	Day 7	Day 0	Day 4	Day 7
BRPCU-1 × BRPCU-2	22.13^{kjl}	20.28^{ml}	18.90^{k}	13.64^{jkihl}	11.02^{hi}	9.77^{kml}	37.08^{n}	34.36^{lmn}	31.06^{k}	4.05^{jkhi}	4.07^{kgjih}	4.92^{hi}
BRPCU-1 × BRPCU-3	20.49^{nm}	17.92^{qp}	15.84^{qp}	13.36^{jkil}	10.24^{ji}	8.99^{nomp}	37.19^{n}	30.86^{r}	27.24^{no}	4.50^{fgde}	5.91^{a}	5.55^{dc}
BRPCU-1 × BRGCU-4	25.85^{dc}	21.84^{jhi}	20.22^{i}	17.68^{a}	14.05^{cd}	10.81^{gjih}	47.72^{ba}	39.36^{gh}	33.83^{hg}	2.67^{ts}	3.00^{pno}	5.43^{de}
BRPCU-1 × BRPCU-5	23.02^{ji}	22.98^{feg}	19.59^{j}	14.75^{fehg}	13.16^{fde}	9.97^{kjl}	41.43^{kjl}	39.67^{gfh}	32.12^{ji}	4.86^{cd}	3.99^{kjih}	5.79^{c}
BRPCU-1 × BRPCU-6	25.06^{edf}	21.01^{jlk}	14.89^{ts}	13.64^{jkihl}	8.94^{k}	7.28^{q}	42.47^{kijh}	32.91^{opn}	23.99^{q}	3.54^{nlm}	3.33^{mn}	4.08^{klm}
BRPCU-1 × BRPCU-7	24.44^{egf}	20.63^{l}	14.98^{s}	15.97^{bedc}	11.13^{hgi}	8.60^{op}	44.32^{egfh}	35.06^{lk}	25.73^{p}	4.42^{fghe}	4.10^{gjih}	4.04^{nlm}
BRPCU-1 × BRPCU-8	26.00^{dc}	23.47^{e}	13.56^{u}	15.08^{fedg}	14.09^{cd}	11.46^{gfeh}	45.07^{egdf}	41.07^{ef}	27.41^{no}	5.33^{b}	4.57^{efd}	5.50^{de}
BRPCU-2 × BRPCU-3	21.52^{kml}	20.69^{lk}	17.38^{ml}	11.25^{m}	9.46^{kj}	8.23^{p}	35.87^{on}	33.05^{opn}	28.13^{nm}	2.77^{rtqs}	3.72^{kl}	3.86^{nlm}
BRPCU-2 × BRGCU-4	19.86^{no}	17.32^{q}	12.97^{v}	11.24^{m}	8.72^{k}	8.28^{p}	34.13^{o}	28.60^{s}	23.30^{q}	3.18^{nopq}	4.97^{cb}	5.11^{hgf}
BRPCU-2 × BRPCU-5	23.77^{hgi}	23.37^{fe}	21.48^{gf}	14.63^{fihg}	14.09^{cd}	11.99^{ced}	42.12^{kijl}	42.62^{cd}	37.10^{c}	4.74^{cde}	4.96^{cb}	6.55^{b}
BRPCU-2 × BRPCU-6	23.00^{ji}	19.34^{n}	17.22^{mn}	14.02^{jkihg}	10.44^{ji}	8.83^{nop}	40.64^{kml}	32.69^{opq}	28.61^{m}	3.07^{ropqs}	4.63^{cefd}	5.47^{de}
BRPCU-2 × BRPCU-7	22.48^{kj}	22.05^{hig}	20.30^{i}	13.19^{jkl}	10.89^{hi}	11.06^{gfh}	38.97^{m}	36.17^{jk}	34.42^{fg}	2.98^{rpqs}	3.31^{mn}	3.81^{nm}
BRPCU-2 × BRPCU-8	25.17^{edf}	24.96^{dc}	23.16^{ed}	14.22^{jfihg}	11.65^{hg}	9.76^{kml}	43.22^{gijh}	41.67^{ed}	36.06^{de}	3.13^{rnopq}	3.40^{ml}	4.79^{i}
BRPCU-3 × BRGCU-4	19.40^{o}	18.15^{qp}	15.66^{qr}	15.17^{fedg}	10.90^{hi}	9.22^{noml}	41.09^{kl}	31.67^{rpq}	27.10^{o}	2.71^{rts}	2.72^{pq}	2.91^{p}
BRPCU-3 × BRPCU-5	23.10^{hji}	22.44^{fhig}	19.16^{kj}	14.24^{jfihg}	13.61^{cde}	10.88^{gih}	40.69^{kml}	39.55^{gfh}	32.43^{ji}	2.36^{t}	2.56^{q}	2.68^{p}
BRPCU-3 × BRPCU-6	26.87^{bac}	26.28^{a}	25.72^{b}	14.99^{fedg}	14.12^{cd}	14.87^{a}	46.03^{ebdc}	44.52^{b}	42.95^{a}	4.25^{jfghi}	4.42^{gef}	5.25^{gef}
BRPCU-3 × BRPCU-7	26.11^{bdc}	24.49^{d}	20.62^{ih}	14.74^{fehg}	13.85^{cde}	9.61^{nml}	44.96^{egdf}	41.81^{ed}	33.56^{hg}	3.97^{jki}	4.74^{cebd}	6.41^{b}
BRPCU-3 × BRPCU- 8	24.51^{egf}	21.58^{jik}	21.07^{gh}	15.47^{fedc}	14.39^{cb}	12.61^{cb}	43.78^{gifh}	39.70^{gf}	36.95^{dc}	3.19^{nopq}	4.27^{gfh}	5.21^{hgef}
BRGCU-4 × BRPCU-5	13.91^{r}	10.96^{t}	9.51^{y}	7.50^{o}	7.02^{l}	5.59^{r}	23.24^{r}	19.72^{u}	16.33^{s}	1.67^{u}	2.66^{pq}	2.74^{p}
BRGCU-4 × BRPCU-6	16.64^{q}	15.01^{r}	14.34^{t}	9.42^{n}	8.86^{k}	7.35^{q}	28.85^{q}	26.06^{t}	26.99^{o}	3.84^{jkl}	4.40^{gef}	3.80^{nm}
BRGCU-4 × BRPCU-7	12.27^{s}	11.32^{ts}	10.43^{x}	6.58^{o}	4.87^{m}	5.99^{r}	20.63^{s}	17.79^{v}	18.03^{r}	3.09^{ropqs}	3.50^{ml}	3.41^{o}
BRGCU-4 × BRPCU-8	17.33^{qp}	12.12^{s}	11.30^{w}	10.65^{m}	5.29^{m}	5.95^{r}	30.83^{p}	19.04^{vu}	18.47^{r}	4.30^{fghi}	4.82^{cbd}	5.08^{hg}
BRPCU-5 × BRPCU-6	24.37^{gf}	23.41^{e}	15.47^{qrs}	12.92^{kl}	10.46^{ji}	9.51^{nml}	40.93^{kl}	37.21^{ji}	27.05^{o}	4.08^{jkghi}	3.46^{ml}	3.35^{o}
BRPCU-5 × BRPCU-7	21.06^{ml}	19.13^{on}	16.73^{on}	12.59^{l}	11.22^{hgi}	11.14^{gfeh}	36.92^{n}	33.30^{omn}	29.83^{l}	3.39^{nopm}	4.15^{gih}	4.95^{hi}
BRPCU-5 × BRPCU-8	23.73^{hgi}	19.50^{mn}	15.18^{rs}	14.07^{jkihg}	12.20^{fg}	11.83^{cfed}	41.53^{kjl}	34.62^{lm}	29.60^{l}	3.36^{nop}	3.89^{kji}	3.36^{o}
BRPCU-6 × BRPCU-7	17.78^{p}	17.37^{q}	16.36^{op}	10.59^{m}	11.12^{hgi}	8.74^{nop}	31.12^{p}	31.24^{rq}	27.56^{no}	5.12^{cb}	3.88^{kji}	4.47^{j}
BRPCU-6 × BRPCU-8	27.55^{a}	26.96^{a}	26.28^{a}	12.13^{l}	11.28^{hgi}	5.50^{r}	40.29^{ml}	39.61^{gfh}	35.21^{fe}	2.38^{t}	2.64^{pq}	3.78^{n}
BRPCU-7 × BRPCU-8	27.14^{ba}	25.97^{b}	22.77^{e}	14.78^{fehg}	13.75^{cde}	10.93^{gfih}	46.10^{ebdac}	43.61^{cb}	36.74^{dc}	5.91^{a}	5.85^{a}	7.46^{a}
RS-03602833 (Check)	24.29^{gf}	22.15^{hig}	20.40^{i}	13.64^{jkihl}	12.85^{fe}	11.05^{gfh}	42.00^{kijl}	38.09^{ih}	34.55^{fg}	3.84^{jkl}	4.69^{cebd}	5.29^{dgef}
BRPCU-1	25.55^{ed}	25.30^{bdc}	23.56^{d}	17.57^{a}	16.78^{a}	12.36^{cbd}	46.84^{bdac}	45.99^{a}	39.72^{b}	1.62^{u}	2.87^{pqo}	4.40^{j}
BRPCU- 2	24.21^{hgf}	21.84^{jhi}	17.73^{ml}	16.52^{bac}	15.35^{b}	11.65^{gfed}	44.67^{egf}	39.41^{gh}	32.06^{ji}	2.66^{ts}	2.81^{pq}	3.37^{o}
BRPCU-3	26.10^{dc}	25.84^{bc}	24.44^{c}	14.16^{jkihg}	13.88^{cde}	12.85^{b}	44.32^{egfh}	43.61^{cb}	42.13^{a}	3.46^{nolm}	3.75^{kjl}	4.11^{kl}
BRGCU-4	6.85^{t}	5.31^{u}	5.13^{z}	3.61^{p}	3.05^{n}	2.60^{s}	11.53^{t}	8.99^{w}	7.88^{t}	2.95^{rpqs}	2.90^{pqo}	3.82^{nm}
BRPCU-5	21.82^{kl}	18.31^{op}	18.62^{k}	10.95^{m}	10.83^{hi}	8.43^{op}	35.51^{on}	31.97^{orpq}	29.71^{l}	3.79^{klm}	4.54^{efd}	5.11^{hgf}

Table 3: Continue...

Table 3: Continue...

BRPCU-6	27.70^{a}	22.59^{fheg}	18.97^{kj}	16.71^{ba}	12.15^{fg}	11.13^{gfeh}	47.99^{a}	38.13^{gih}	33.03^{hi}	3.10^{rnopqs}	3.34^{mn}	4.34^{kj}
BRPCU-7	27.75^{a}	26.38^{a}	21.76^{f}	14.97^{fedg}	13.64^{cde}	10.10^{kjil}	47.05^{bac}	43.94^{cb}	35.02^{f}	4.56^{fde}	5.03^{b}	5.38^{def}
BRPCU-8	25.12^{edf}	21.81^{jhi}	17.92^{l}	16.10^{bdc}	13.99^{cd}	11.14^{gfeh}	45.34^{edfc}	39.27^{gh}	31.95^{jk}	1.84^{u}	3.19^{mno}	4.51^{j}
CD	0.998	0.732	0.579	1.073	0.973	0.777	1.691	1.374	0.913	0.383	0.331	0.253
SEM (±)	0.353	0.244	0.205	0.380	0.344	0.275	0.599	0.486	0.323	0.136	0.117	0.090
CV	2.72	2.59	1.992	4.933	5.213	4.953	2.643	2.404	1.860	6.647	5.174	3.375

Values marked with same letter (s) are not significantly different as per DMRT at 1% level of significance.

Moalemiyan and Ramaswamy (2012) and Jia *et al.* (2018) in cucumber. The amount of carotenoid in cucumber fruits of different parents and hybrids increased gradually during storage periods. In fresh cucumber fruits, the significantly higher amount of carotenoid was observed in parent BRPCU-7, while hybrid of BRPCU-7 × BRPCU-8 showed the highest carotenoid content during storage periods.

CONCLUSION

The results of performed study it can be concluded that among genotypes parental line BRGCU-4 alone and its crosses BRGCU-4 × BRPCU-6, followed by BRGCU-4 × BRPCU-8 retained the minimum moisture loss and higher fruit firmness during storage. While, the inbred BRPCU-8 and its hybrids reserved with the highest TSS and acidity during period of storage. Whereas, the cucumber inbred line BRPCU-3 showed the highest chlorophyll content on 7th day of storage, Moreover, the genotype BRPCU-7 and cross of BRPCU-3 × BRPCU-6 reported with both higher chlorophyll and carotenoid content during storage periods that keep it more attractive and quality retentive during storage. Therefore, these genotypes were found to be suitable for transportation, marketing and can be stored well under natural environment conditions.

ACKNOWLEDGEMENT

The authors are thankful to Bihar Agriculture University, Bhagalpur, Bihar and Lovely Professional University, Punjab for providing the infrastructural support.

Authors contribution

All the authors contributed equally to this work.

Funding details

There is no funding resource applicable to the proposed work.

Data availability statement

All the related data to the research work is being represented in the tables.

Conflict of interest

The authors declare no competing interests for the proposed study.

REFERENCES

Amin, M.R., Nahid, S. and Suh, S.J. (2021). Impact of pollinator insects associated with cucumber fruit set. Agric. Sci. Digest. 41(4): 615-619. doi: 10.18805/ag.D-290.

Dhall, R.K., Sharma, S.R. and Mahajan, B.V.C. (2012). Effect of shrink wrap packaging for maintaining quality of cucumber during storage. J. Food Sci. Technol. 49(4): 495-499. https://doi.org/10.1007/s13197-011-0284-5.

Jia, B., Zheng, Q., Zuo, J., Gao, L., Wang, Q., Guan, W. and Shi, J. (2018). Application of postharvest putrescine treatment to maintain the quality and increase the activity of antioxidative enzyme of cucumber. Sci. Hortic. 239: 210-215. https://doi.org/10.1016/j.scienta.2018.05.043.

Lichtenthaler, H.K. and Buschmann, C. (2001). Chlorophylls and Carotenoids-measurement and Characterisation by UV-VIS. In: Current Protocols in Food Analytical Chemistry (CPFA), (supplement 1), F4.3.1 - F 4.3.8, John Wiley, New York.

Manjunatha, M. and Anurag, R.K. (2014). Effect of modified atmosphere packaging and storage conditions on quality characteristics of cucumber. J. Food Sci. Technol. 51(11): 3470-3475. https://doi.org/10.1007/s13197-012-0840-7.

Moalemiyan, M. and Ramaswamy, H.S. (2012). Quality retention and shelf-life extension in Mediterranean cucumbers coated with a pectin-based film. J. Food Res. 1(3): 159-168. https://doi.org/10.5539/jfr.v1n3p159.

Nilsson, T. (2005). Effects of ethylene and 1-MCP on ripening and senescence of European seedless cucumbers. Postharvest Biol. Technol. 36(2): 113-125. https://doi.org/10.1016/j.postharvbio.2004.11.008.

Omoba, O.S. and Onyekwere, U. (2016). Postharvest physicochemical properties of cucumber fruits (*Cucumber sativus* L.) treated with chitosan-lemon grass extracts under different storage durations. African J. Biotechnol. 15(50): 2758-2766. https://doi.org/10.5897/AJB2016.15561.

Ozden, C. and Bayindirli, L. (2002). Effects of combinational use of controlled atmosphere, cold storage and edible coating applications on shelf life and quality attributes of green peppers. Eur. Food Res. Technol. 214: 320-326. doi: 10.1007/s00217-001-0448-z.

Raghav, P.K. and Saini, M. (2018). Development of mint (*Mentha viridis* L.) herbal edible coating for shelf-life enhancement of cucumber (*Cucumis sativus* L.). Int. J. Green Herb. Chem. 7(2): 379-391.

Rangana, S. (1977). Manual of Analysis of Fruit and Vegetable Products. Tata McGraw-Hill Publication, New Delhi, India. pp. 1-20.

Seymour, G.B., Taylor, J.E. and Tucker, G.A. (1993). Biochemistry of fruit ripening. 1st ed., Springer Dordrecht. pp. 1-454. https://doi.org/10.1007/978-94-011-1584-1.

Shabbir, M.A., Zeshan, M.A., Iftikhar, Y., Anwar, U., Sajid, A., Bakhtawar, F., Mahmood, R. and Ghani, M.U. (2020). Management of cucumber mosaic virus through organic and inorganic extracts in greenhouse. Agric. Sci. Digest. 40(2): 175-177.

Singh, N., Jat, M.K. and Singh, B. (2021). Outbreak of leaf miner and root knot nematode-wilt disease complex on cucumber- a new threat under protected cultivation in district Gurugram Haryana. Agric. Sci. Digest. 41(3): 460-463. doi: 10.18805/ag.D-5250.

Sumita, K. and Vivekananda, Y. (2023). A Southern root-knot nematode (*Meloidogyne incognita*) first reported on cucumber in Manipur. Indian J. Agric. Res. pp. 1-3. doi: 10.18805/IJARe.A-6105.