



Genetic Evaluation and Assessment of Parthenocarpic Cucumber (*Cucumis sativus* L.) Genotypes

Guravtar Singh, Navjot Singh Dhillon*, Gurmehak Deep Singh and Mamta

Department of Vegetable Science, Agriculture, Khalsa College, Amritsar-143 001, India
*E-mail: navjotsingh@khalsacollege.edu.in

Abstract: The genetic diversity of fourteen quantitative and qualitative traits was evaluated across thirteen parthenocarpic cucumber genotypes in the northern plains of India. Based on overall performance, the hybrids Kian, Punjab Kheera Hybrid-11, and check variety (Punjab Kheera-1) were determined to be the most promising for fruit yield per plant and several other horticultural attributes. The phenotypic coefficient of variation was higher than the genotypic coefficient of variation for traits such as the nodal position of the first female flower, the number of female flowers per node, the number of fruits per plant, and marketable yield per plant. Moderate variation was noted for days to anthesis of the first female flower, fruit length, internodal length, vine length, and total soluble solids. High heritability was observed for all traits except harvest duration. Traits such as the nodal position of the first female flower, the number of female flowers per node, fruit length, the number of fruits per plant, internodal length, and vine length exhibited high heritability coupled with high genetic advance. This indicates a predominance of additive gene action, suggesting that direct selection for these traits is advisable to enhance parthenocarpic cucumber production.

Keywords: Cucumber, Genotypes, Heritability, Phenotypic, Variability

Cucumber (*Cucumis sativus* L.), a key horticultural crop belonging to the Cucurbitaceae family and can be grown in both summer and rainy seasons in an open environment (Kaur et al 2023). However, their productivity may be low due to various abiotic stresses like low temperatures and unpredictable weather, as well as biotic stresses such as red pumpkin beetles, fruit flies, and downy or powdery mildew, therefore cultivating cucumbers in protected environments can be a more profitable option (Dhillon et al 2017) as protected farming can minimize both biotic and abiotic stresses (Reddy et al 2023). Genetic variability is essential in base population for the successful crop improvement for the yield and its associated characters (Luther et al 2024). The accomplishment of crop enhancement program be contingent upon the degree of variability present in the inhabitants (Meena and Bahadur 2014). The development of promising genotypes largely depends on the extent of genetic variability present for the desired traits (Singh et al 2022). Key biometric tools for assessing genetic variability include the genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, and genetic advance. Most of the farmers use private sector hybrids which are available in the market, although the cost of the seeds is very expensive owing to that most of the farmers not afford them. Therefore, it is necessary to create public sector varieties/hybrids suitable for cultivation under protected cultivation. This study aims to calculate the degree of variance among horticultural traits and to identify

the most promising hybrid(s)/varietie(s) of parthenocarpic cucumber.

MATERIAL AND METHODS

The experiment was laid out during the spring summer season 2022-2023, by evaluating the thirteen genotypes with three replications with RBD design at Vegetable Research Farm, Department of Agriculture, Khalsa College, Amritsar (Table 1). Nursery was sown in soilless media (cocopeat, perlite and vermiculite in 3:1:1, respectively) and transplanting was done at 2-3 true leaf stage in natural ventilated polyhouse (250 m²). In each replication 20 plants of each hybrid were planted at a spacing of 90 cm x 30 cm. Through the crop growing season, irrigation, fertigation, earthing up, fertilizing, stacking and crop protection measures are implemented as part of the PAU, Ludhiana (Package of practices 2021). The observations were made on the following characteristics: days taken to first female flower anthesis, first female flower nodal location, number of female flowers per node, days taken to first fruit harvest, fruit length, fruit girth, fruit weight, number of fruits per plant, marketable yield per plant, harvest duration, internodal length, vine length and total soluble solids. Using the analysis of variance, trait were analysed. The GCV, PCV, heritability, and genetic advance were calculated using the WINDOSTAT software program.

RESULTS AND DISCUSSION

Growth parameters: One of the cucumber's most desired

qualities is its earliness, since early in the season, market prices are typically higher. Significant variations in the days to first picking were seen among the genotypes studied (Table 2). Hybrid Kian took the fewest days to anthesis of the first female flower, but three genotypes, PPC-6, Punjab kheera-1, and KPCH-1, were statistically at par this was due to the relation between appropriate climatic conditions and genotype genes. Similar observations noted in cucumber for minimum days taken to anthesis of first female flower by Shaju et al (2020) in variety Kohinoor (36.09 days) and Tripathi et al (2021) in genotype BRPCU-1 (24.06 days).

PPC-2 was produced the first female flower at the lowest node, while other genotypes PPC-3, PKH-11 and Kian were

statistically comparable (Table 2). For number of female flowers per node line KCA-PC-2 was superior whereas KCA-PC-3, KCA-PC-1 and Apsara were statistically at par. as Choudhari et al (2016) observed minimum days to anthesis of first female flower in cucumber variety RS-03602833 (25.00 days) and Mehta and Sharma (2020) had maximum number of female flowers per node in cucumber variety PPC-3 (2.38). The early maturing genotype is crucial for securing early markets, as hybrid Kian took the least number of days to first harvest and matured the earliest, whereas PPC-6, Punjab Kheera-1, and KPCH-1 were statistically at par. This was due to the higher photosynthesis in these genotypes which stimulates the initiation of flowers.

Table 1. Parthenocarpic cucumber genotypes used in study and their sources

| Genotypes | Source |
|--|--|
| Punjab Kheera-1 (Standard check) | Punjab Agricultural University (PAU) |
| Punjab Kheera Hybrid-11 (PKH-11) | Punjab Agricultural University (PAU) |
| Kerala Parthenocarpic Cucumber Hybrid-1 (KPCH-1) | Kerala Agricultural University (KAU) |
| Kian | Nunhems Seeds Pvt. Ltd. |
| Adiva | Tropica Seeds Pvt. Ltd. |
| Apsara | Acsen Hyveg Pvt. Ltd. |
| Yamchu | Takoyama Plant Science |
| Pusa Parthenocarpic Cucumber-6 (PPC-6) | Indian Agricultural Research Institute (IARI) |
| Pant Parthenocarpic Cucumber-2 (PPC-2) | G.B. Pant University of Agriculture. Pantnagar |
| Pant Parthenocarpic Cucumber-3 (PPC-3) | G.B. Pant University of Agriculture. Pantnagar |
| KCA-PC-1 | Khalsa College, Amritsar |
| KCA-PC-2 | Khalsa College, Amritsar |
| KCA-PC-3 | Khalsa College, Amritsar |

Table 2. Mean performance of parthenocarpic cucumber genotypes for growth and yield traits

| Genotypes | Days to anthesis of first female flower | Nodal position of first female flower | Number of female flowers per node | Days taken to first fruit harvest (days) | Fruit length (cm) | Fruit girth (cm) |
|-----------------|---|---------------------------------------|-----------------------------------|--|-------------------|------------------|
| Adiva | 25.00 | 3.00 | 1.89 | 40.67 | 14.00 | 12.50 |
| PPC-2 | 25.37 | 2.78 | 1.71 | 43.00 | 16.00 | 13.77 |
| PKH-11 | 24.33 | 2.93 | 1.12 | 40.00 | 15.33 | 12.00 |
| KCA-PC-1 | 32.00 | 4.19 | 3.08 | 48.67 | 16.33 | 12.33 |
| Apsara | 25.23 | 3.63 | 3.00 | 42.67 | 16.17 | 13.17 |
| KCA-PC-2 | 27.33 | 4.50 | 3.40 | 45.67 | 13.33 | 12.17 |
| KPCH-1 | 24.00 | 4.09 | 2.07 | 39.67 | 14.83 | 11.83 |
| KCA-PC-3 | 32.33 | 6.25 | 3.29 | 48.67 | 15.67 | 13.23 |
| Yamchu | 25.67 | 4.39 | 2.82 | 44.67 | 19.67 | 12.27 |
| PPC-3 | 31.33 | 3.17 | 1.30 | 47.00 | 20.83 | 12.83 |
| Kian | 21.67 | 2.93 | 1.14 | 37.00 | 14.50 | 11.07 |
| PPC-6 | 23.33 | 4.60 | 1.86 | 38.67 | 13.50 | 12.20 |
| Punjab Kheera-1 | 23.67 | 3.23 | 1.91 | 39.00 | 14.17 | 11.90 |
| CD (p=0.05) | 2.20 | 0.38 | 0.15 | 3.64 | 0.90 | 0.48 |

Patra et al (2023) having similar results as cucumber hybrid Adiva took minimum days (52.60) to harvest.

Marketable yield and consumer preference are directly impacted by fruit girth, length and weight. PPC-3 outperformed for fruit length, whereas Yamchu and KCA-PC-1 were statistically at par (Table 3). Fruit girth was maximum in PPC-2 while genotypes viz., KCA-PC-3, Apsara and Kian were statistically at par. For fruit weight, Apsara had the highest weight from all the hybrids, whereas other genotypes such as Yamchu, PPC-2, and PPC-3 were statistically comparable. Fruit length, girth and weight was higher in these lines due to genetic makeup of the genotype as well as the proper supply of nutrition's during the growth of the fruit. The commercial viability of a variety is determined by its yield and number of fruits produced per plant. Among all hybrids, hybrid PKH-11 produced the most fruits per plant, substantially more than the other genotypes but statistically at par with the genotypes Punjab kheera-1, Kian and KCA-PC-2. But hybrid Kian had maximum yield per plant which was statistically at par with variety (Punjab Keera-1), hybrid (PKH-11 and Apsara). Kumar et al (2024) demonstrated maximum number of fruits (30.47) and yield per vine (3.87 kg) in cucumber genotype BRPCU-7.

Prolonged availability of marketable fruits was found in Kian, which was statistically comparable to other genotypes Punjab Kheera-1, KCA-PC-2 and PKH-11. Shorter internodal length was also in hybrid Kian, whereas genotype PPC-6, hybrid Apsara and variety Punjab kheera-1 were statistically at par due to the genetic makeup of cultivars. For plant height KCA-PC-2 was found to be much taller than the other

genotypes, but Yamchu, PPC-2 and Apsara, statistically equal. This might be due to certain genes that control and express varietal qualities, such as height, shortness, and other physical features, in response to the growing environment. Dhillon et al (2017) has similar findings had maximum harvest duration (54.67 days), inter-nodal length (9.86 cm) and vine length (2.42 m) in hybrid Kian. The crucial component of fresh cucumber ingestion is total soluble solids, hybrid PKH-11 had the highest total soluble solids, although it was at par with Adiva, hybrid Yamchu, and variety PPC-3 (Table 3). Dhall (2019) had maximum TSS (2.60°Brix) in variety Punjab Kheera-1.

Genetic variability: Higher values of both phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were observed nodal position of the first female flower, the number of female flowers per node and the number of fruits per plant (Table 4). In contrast, marketable yield per plant showed a significant GCV but not PCV, indicating that environmental factors have minimal influence on these traits. As a result, direct selection could be effectively applied to these traits in early segregating populations. Ahirwar and Singh (2018) and Patra et al (2023) showed similar trends in cucumbers with regard to PCV and GCV for number of fruits per plant, nodal position of the first female flower and marketable yield per plant.

Moderate values of both phenotypic coefficient PCV and GCV were observed for traits internodal length, vine length, and total soluble solids. Additionally, PCV was moderate for the number of fruits per plant, days to first fruit harvest and harvest duration. In contrast, GCV was moderate only for the

Table 3. Mean performance of parthenocarpic cucumber genotypes for growth, yield and quality traits

| Genotypes | Fruit weight (gm) | Number of fruits per plant | Marketable yield per plant (kg) | Harvest duration (days) | Internodal length (cm) | Vine length (m) | Total soluble solids (°Brix) |
|-----------------|-------------------|----------------------------|---------------------------------|-------------------------|------------------------|-----------------|------------------------------|
| Adiva | 144.69 | 16.10 | 2.33 | 54.00 | 10.23 | 3.87 | 3.60 |
| PPC-2 | 155.13 | 13.97 | 2.16 | 50.00 | 12.21 | 3.26 | 3.03 |
| PKH-11 | 118.64 | 26.56 | 3.15 | 57.33 | 10.15 | 4.06 | 3.90 |
| KCA-PC-1 | 149.14 | 11.76 | 1.75 | 50.00 | 10.19 | 3.46 | 2.64 |
| Apsara | 169.57 | 17.79 | 3.01 | 56.33 | 9.25 | 3.32 | 2.81 |
| KCA-PC-2 | 134.71 | 20.08 | 2.70 | 57.67 | 10.18 | 4.34 | 2.52 |
| KPCH-1 | 148.28 | 17.23 | 2.55 | 54.33 | 10.90 | 4.18 | 2.71 |
| KCA-PC-3 | 148.92 | 16.26 | 2.42 | 55.67 | 12.40 | 4.26 | 2.91 |
| Yamchu | 162.17 | 11.77 | 1.91 | 55.33 | 12.69 | 3.16 | 3.46 |
| PPC-3 | 150.22 | 13.71 | 2.06 | 51.33 | 13.98 | 4.25 | 3.23 |
| Kian | 139.77 | 24.18 | 3.37 | 58.67 | 7.64 | 4.20 | 3.10 |
| PPC-6 | 141.18 | 20.03 | 2.83 | 55.67 | 8.89 | 3.39 | 3.04 |
| Punjab Kheera-1 | 131.44 | 24.70 | 3.25 | 58.00 | 9.70 | 2.91 | 2.83 |
| CD (p=0.05) | 5.17 | 1.15 | 0.13 | 3.21 | 0.23 | 0.32 | 0.33 |

days to anthesis of the first female flower and total soluble solids, indicating limited variation among the genotypes. Mehta and Sharma (2020) also reported moderate estimates of PCV and GCV in cucumber for the days taken to anthesis of the first female flower, vine length and internodal length. Low values of PCV and GCV were observed for fruit girth, fruit weight and harvest duration, indicating minimal genetic variation. These traits may not require improvement and can be effectively utilized in hybridization programs. Similar trend for PCV and GCV in cucumber observed for harvest duration and fruit weight (Tripathi et al 2021).

Heritability: The high heritability estimates were for traits such as internodal length, the number of female flowers per node, number of fruits per plant, marketable yield per plant, nodal position of the first female flower, fruit weight, fruit length, days to anthesis of the first female flower, vine length, and fruit girth (Table 4). Similar patterns were observed by Singh and Dhillon (2022) in parthenocarpic cucumbers, with the highest heritability for internodal length and number of female flowers per node. Moderate heritability was observed for days taken to first fruit harvest, total soluble solids and harvest duration. Similar results were also noted by Kumar et al. (2024) in cucumber for harvest duration. High broad-sense heritability indicates that a significant portion of the phenotypic variance is due to genotypic variance for all traits, except for harvest duration, which had the lowest heritability estimate. Traits with high heritability are less influenced by environmental factors, making selection based on phenotypic performance more reliable.

Genetic advance: The high genetic advance (% of mean)

was observed for traits such as the number of female flowers per node, the number of fruits per plant, the nodal position of the first female flower, marketable yield per plant, internodal length, fruit length, and vine length (Table 4). Comparable evidence of higher genetic advancement in cucumber reported by Singh et al (2017) for marketable yield per plant and vine length. Moderate genetic advance (GA) was observed for the traits such as days to anthesis of the first female flower, total soluble solids, fruit weight and days to first fruit harvest, whereas low genetic advance was observed for fruit girth and harvest duration. Kumar et al (2024) also had moderate genetic advance for days to anthesis of the first female flower and lower for harvest duration.

Higher genetic advancement and heritability were observed for number of female flowers per node, nodal position first female flower's nodal position, number of fruits per plant, fruit length, marketable yield per plant, vine length and internodal length, which shown the importance of additive gene action for these traits inheritance and suggested that phenotypic selection may be use to further improve them. These findings were consistent with the results of Mishra et al (2020), Bisht et al (2022) and Kumar et al (2024). High GCV, PCV, heritability along with high estimates of genetic advance was verified for nodal position of first female flower, number of female flowers per node, number of fruits per plant and marketable yield per plant. Majority of additive gene action which recommended that these traits can be improved through direct selection (Tripathi et al 2021, Bisht et al 2022).

Table 4. Measures of variability parameters (GCV, PCV, heritability and genetic advance) for different characters in parthenocarpic cucumber genotypes

| Traits | Grand mean | Phenotypic coefficient of variation (%) | Genotypic coefficient of variation (%) | Heritability (%) | Genetic advance value % mean |
|---|------------|---|--|------------------|------------------------------|
| Days taken to anthesis of first female flower | 26.25 | 13.88 | 12.95 | 87.09 | 24.91 |
| Nodal position of first female flower | 3.82 | 26.24 | 25.56 | 94.83 | 51.27 |
| Number of female flowers per node | 2.19 | 37.46 | 37.22 | 98.73 | 76.19 |
| Days taken to first fruit harvest | 42.71 | 10.09 | 8.72 | 74.74 | 15.54 |
| Fruit length (cm) | 15.71 | 14.59 | 14.18 | 94.37 | 28.37 |
| Fruit girth (cm) | 12.41 | 5.99 | 5.52 | 85.10 | 10.50 |
| Fruit weight (g) | 145.68 | 9.22 | 8.98 | 94.77 | 18.01 |
| Number of fruits per plant | 18 | 27.21 | 26.94 | 98.00 | 54.94 |
| Marketable yield per plant (kg) | 2.57 | 20.61 | 20.37 | 97.64 | 41.46 |
| Harvest duration (days) | 54.94 | 6.03 | 4.92 | 66.71 | 8.29 |
| Internodal length (cm) | 10.65 | 16.47 | 16.40 | 99.21 | 33.67 |
| Vine length (m) | 3.74 | 14.10 | 13.11 | 86.42 | 25.10 |
| Total soluble solids (°Brix) | 3.01 | 14.28 | 12.42 | 75.60 | 22.25 |

CONCLUSION

Parthenocarpic cucumber hybrids (Kian and Punjab Kheera Hybrid-11 and Punjab Kheera-1) and varieties (Pusa Parthenocarpic Cucumber-6 and Pant Parthenocarpic Cucumber-3) were superior for growth, yield and quality attributes. PCV and GCV estimates were recorded as high and moderate for days to anthesis of the first female flower, nodal position of the first female flower, number of female flowers per node, number of fruits per plant, internodal length, vine length, and total soluble solids. This indicates the presence of variability, providing significant opportunities for improvement through hybridization or selection. Additionally, high heritability combined with high genetic advance was observed for the nodal position of the first female flower, number of female flowers per node, fruit length, number of fruits per plant, marketable yield per plant, internodal length, and vine length. This suggests that additive gene action plays a key role in the inheritance of these traits, allowing for further improvement through phenotypic selection.

REFERENCES

- Ahirwar CS and Singh DK 2018. Assessment of genetic variability in cucumber (*Cucumis sativus* L.). *International Journal of Current Microbiology and Applied Science* **7**: 813-822.
- Bisht YS, Singh DK, Singh NK, Singh D and Singh SS 2022. Studies of genetic variability in parthenocarpic cucumber (*Cucumis sativus* L.). *The Pharma Innovation Journal* **11**: 2205-2209.
- Chaudhari V, Kumar S and Tank RV 2016. Evaluation of greenhouse cucumber for various horticultural traits under naturally ventilated polyhouse. *Advances in Life Sciences* **5**: 3320-3322.
- Dhall RK 2019. Punjab Kheera-1: A new variety of parthenocarpic cucumber for poly-net house cultivation. *Vegetable Science* **46**: 135-138.
- Dhillon NS, Sharma P and Kumar P 2017. Effect of shoot pruning on polyhouse grown cucumber (*Cucumis sativus* L.). *Indian Journal of Ecology* **44**(2): 390-392.
- Kaur H, Manchanda P, Kumar P, Dhall RK, Chhuneja P and Weng Y 2023. Genome-wide identification and characterization of parthenocarpic fruit set-related gene homologs in cucumber (*Cucumis sativus* L.). *Nature Portfolio* **13**: 2403.
- Kaur M and Sharma P 2022. Performance of parthenocarpic cucumber (*Cucumis sativus* L.) genotypes for yield and quality characters under protected environment. *Himachal Journal of Agricultural Research* **48**(2): 220-224.
- Kumar S, Singh P and Bhardwaj A 2024. Genetic variability and character association in parthenocarpic cucumber (*Cucumis sativus* L.) under protected cultivation. *Plant Archives* **24**: 210-217.
- Luther S, Ram CN, Jha A and Kumar A 2024. Studies on heritability (Narrow sense) and genetic advance analysis for growth, fruit yield and its component traits in cucumber (*Cucumis sativus* L.). *International Journal of Advanced Biochemistry Research* **8**(8): 248-251.
- Meena OP and Bahadur V 2014. Assessment of genetic variability, heritability and genetic advance among tomato (*Solanum lycopersicum* L.) germplasm. *The Bioscan* **9**(4): 1619-1623.
- Mehta P and Sharma P 2020. Genetic evaluation of fruit yield and related traits in parthenocarpic cucumber. *International Journal of current microbiology and applied science* **9**: 1388-1404.
- Mishra SK, Roy S, Kumar N and Prasad VM 2020. Genetic evaluation of cucumber (*Cucumis sativus* L.) genotypes for yield and yield contributing traits. *Journal of Pharmacognosy and Phytochemical* **10**: 2872-2874.
- Package of Practices for cultivation of vegetables 2021. Punjab Agricultural University, Ludhiana.
- Patra S, Singh DK, Singh SS and Negi M 2023. Assessment of genetic diversity of parthenocarpic cucumber (*Cucumis sativus* L.) genotypes under polyhouse condition. *The Pharma Innovation Journal* **12**(7): 1532-1538.
- Reddy PSK, Muthulakshmi S and Reddy PSS 2023. Influence of environmental factors, growing conditions and seasonal variations on vegetative, yield and quality characters of cucumber (*Cucumis sativus* L.) varieties. *Indian Journal of Ecology* **50**(5): 1695-1700.
- Shaju AA, Fatmi U and Singh D 2020. Evaluation of different cucumber (*Cucumis sativus* L.) hybrids for their growth and yield under Prayagraj Agro-climatic conditions. *International Journal of Current Microbiology and Applied Science* **9**: 1194-1201.
- Singh G and Dhillon NS 2022. Genetic variability studies in parthenocarpic cucumber. *The Pharma Innovation Journal* **11**: 2142-2147.
- Singh SP, Malik S, Singh B, Gangwar LK, Singh MK, Kumar M and Chandra A 2022. Studies on genetic variability, heritability, and genetic advance for selection of genotypes in Cucumber (*Cucumis sativus* L.). *The Pharam Innovation* **11**(7): 2535-2537.
- Singh Y, Safiullah, Verma A, Sharma S and Sekhon BS 2017. Genetic evaluation of cucumber (*Cucumis sativus* L.) genotypes for yield and its contributing traits under mid-hill conditions of Himachal Pradesh, India. *Environment and Ecology* **35**: 3621-3626.
- Tripathi V, Singh VK, Bhardwaj A, Singh RS, Srinivasaraghavan A and Kumari A 2021. Mean performance and genetic variability of parthenocarpic gynocercous cucumber inbreds under protected conditions of Eastern India. *Journal of Current Opinion in Crop Science* **2**: 178-183.