Genetic Divergence Studies in Cucumber (Cucumis sativus L.) Genotypes for Yield and Quality

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A B S T R A C T

The present study was carried out during Late kharif, 2016 at College of Horticulture, Anantharajupeta. The experiment was conducted with an objective to identify divergent genotypes to be used as donor parents in crop improvement. Thirty-two genotypes along with two checks were evaluated in a randomized block design with three replications and the data on 25 yield and yield attributing traits were recorded. The analysis of variance revealed significant differences among all genotypes indicating the presence of sufficient amount of variability for the characters studied. Wide range of variability was observed for number of fruits per plant, fruit weight, fruit yield per plant, powdery mildew incidence and aphid infestation, indicating the scope for selection of suitable initial breeding material for further breeding programme. The genotypes belong to the clusters VI and III, when the D² analysis was carried out for 24 characters which partitioned the thirty-two genotypes into 6 clusters, which are genetically divergent and hybridization between these genotypes will likely produce desirable segregants. The characters like primary branches per plant, days to first male flowering, days to first female flowering, days to 50% male flowering, days to 50% female flowering, days to first fruit harvest, days to last harvest, number of seeds per fruit, TSS, carotenoids, acidity, ascorbic acid and fruit yield per vine recorded high heritability in conjunction with high genetic advance as percent of mean, suggests the predominant role of additive genetic component in governing of these traits and improvement of these traits through simple selection can be employed in cucumber. The genotypes exhibited high variability for most of the traits like plant growth characters, fruit characters, quality and seed characters. On the basis of mean performance of the genotypes studied, in terms of earliness, yield and quality traits, the genotypes viz., A10 (JS 541367), A12 (JB 595504), A22 (IC 321367) and A30 (IC 550207) were found superior and were identified as promising lines for further crop improvement in cucumber.

Keywords
Cucumber genotypes, Genetic variability, Heritability

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Introduction

Cucumber, Cucumis sativus L. (2n=14) is one of the most important cucurbitaceous vegetable crops grown widely in tropical and sub-tropical parts of the world, which is native to the Indian subcontinent (Sebastian et al., 2010). Cucumber is a warm season crop which
is grown extensively throughout the year in southern states of India. In plains of northern India, it is grown in summer and rainy season, but it does not tolerate cold injury (Rastogi, 1998). In the recent past, cucumber has shown tremendous potential and has gained importance as a high value vegetable crop under protected cultivation. It is highly cross-pollinated crop and usually monoecious in nature. Other sex forms viz., androecious, gynoecious, hermaphrodite and andromonoecious can be encountered in cucumber (Bailey, 1969).

The scope of improvement of any crop depends upon the magnitude of genetic variability present in the available germplasm. Greater the variability in the available germplasm, better would be the chances of selecting superior genotypes (Simmonds, 1962). In cucumber too, fruits vary in shape, size, colour, maturity and taste. Before starting any breeding programme, genetic variability must be available in the parental material. Further, phenotypic variability being controlled by environmental factors may not prove effective in crop improvement. Therefore, it is necessary to partition the phenotypic variations into its genetic and environmental components, because in the total variability, not only the heritable genetic components but also genetic advance is important, as it predicts the extent of advancement to next generation through selection.

While selecting for yield, one should take into account the improvement of yield contributing traits, provided that the association of such traits with yield is known. Moreover, correlation and path coefficient analysis have been of immense help in selecting suitable plant type. So, in order to identify the desirable genotypes, there is an urgent need to assess the existing variability for higher yield and quality under specific conditions. Hence, the present investigation was chosen to evaluate the genotypes for better parent for hybridization programme.

Materials and Methods

The present investigation was carried out during Late kharif, 2016 at College of Horticulture, Anantharajupeta, Dr. Y.S.R. Horticultural University, Andhra Pradesh. This location is at an elevation of 162 m (531 feet) above mean sea level lying between the 13059’ North latitude and 79019’ East longitude. The total rainfall during growing season was 255 mm. The maximum and minimum temperatures ranged from 28.14°C to 35.71°C and 18.57°C to 27.57°C respectively. The relative humidity during the period of crop growth ranged between 33.14 to 99.71 %.

Planting material

The experiment was laid-out under a shade net in a randomized block design replicated thrice. In each replication, each genotype was grown in a single row of 6 m length with a spacing of 75 x 60 cm accommodating 10 plants in a replication. The experimental material (Table. 1) comprised of a set of 32 genotypes (30 accessions and 2 checks). Thirty genotypes were obtained from NBPGR, Regional Station, Thrissur and Jodhpur. Two genotypes viz., Multistar RZ F1 and ICPCHI served as checks.

The recommended fertilizer dose of N: P2O5:K2O was applied at the time of field preparation at the rate of 400, 315 and 100 Kg ha⁻¹ as calcium ammonium nitrate, single superphosphate, and muriate of potash, respectively. Seeds were sown in protrays initially, there after transplanted to beds on 15th day. Observations were recorded on vine length, No. of primary branches per plant, inter nodal length, No. of nodes per vine, node
number at which first female flower appearance, days to first male & female flowering, days to 50% male & female flowering, days to first & last fruit harvest, fruit length, diameter, weight, No. of seeds per fruit, 100 seed weight, TSS, Carotenoid content, acidity, ascorbic acid, yield per plant, powdery mildew & aphid incidence in 10 random plants per treatment.

Grouping of the genotypes into different clusters was done by using Torcher’s method as described by Rao (1952). The criterion used in clustering by this method is that any two variables belonging to the same cluster should at least on an average show a smaller $D^2$ value among themselves than those belonging to two different clusters. For this purpose, $D^2$ values of all the possible combinations in each genotype was arranged in increasing order of the magnitude in a tabular form as described by Singh and Choudhary (1985).

Statistical analysis

Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad sense heritability, genetic advance and genetic gain were computed as per standard formulas.

Analysis of variance

The data for different characters were statistically analysed on the basis of the model described by Panse and Sukhatme (1961).

$$Y_{ij} = u + g_i + r_j + e_{ij}$$

Where,
- $Y_{ij}$ = Phenotypic observation in $i^{th}$ genotype and $j^{th}$ replication,
- $u$ = General mean
- $g_i$ = Effect of $i^{th}$ genotype
- $r_j$ = Effect of $j^{th}$ replication
- $e_{ij}$ = Random error associated with $i^{th}$ genotype and $j^{th}$ replication.

Genetic variance

It is the variance contributed by genetic causes or the genetic occurrence of difference among the individuals due to their genetic makeup. It was calculated by using the formula given by Al-Jibouri, 1958.

$$V_g = \frac{MSV - V_e}{r} = \frac{b - c}{r}$$

Where,
- $V_g$ = Genotypic variance,
- MSV = Mean square for varieties,
- VE = Error mean square and
- $r$ = Number of replication

Phenotypic variance

It is the sum of variance contributed by genetic causes and environmental factors and was computed as formula given by Al-Jibouri, 1958.

$$V_p = V_g + V_e$$

Where,
- $V_p$ = Phenotypic variance, $V_g$ = Genotypic variance and $V_e$ = Error variance.

Genotypic coefficient of variation (GCV)

The magnitude of genetic variation existing in a character was estimated by the formula given by Burton (1952).

$$GCV = \frac{\sqrt{V_g}}{\bar{x}} \times 100$$

Where,
- $V_g$ = Genotypic variance and
- $\bar{x}$ = General mean of the character understudy.

Phenotypic coefficient of variation (PCV)

The magnitude of phenotypic variation existing in a character was estimated by the formula given by Burton (1952).
Where, 
\( V_p = \text{Phenotypic variance} \) and 
\( \bar{x} = \text{General mean of the character under study.} \)

**Heritability \([h^2 \text{ broad sense}]\)**

Heritability in the broad sense refers to the proportion of genotypic variance to the total variance observed in total population. Heritability \((h^2)\) in broad sense was calculated according to the formula given by Allard (1960).

\[
h^2 = \frac{V_g}{V_p} \times 100
\]

Where, 
\( h^2 = \text{Heritability (broad sense)} \)
\( V_g = \text{Genotypic variance} \) and 
\( V_p = \text{Phenotypic variance} \)

**Genetic advance (GA)**

This was estimated as per the formula proposed by Johnson et al., (1955).

\[
GA = K \times h_{bs}^2 \times \sigma_p
\]

Where
\( K = \text{Selection differential at 5% selection intensity which accounts to a constant value 2.06 (Lush, 1949).} \)
\( h^2 (b) = \text{Heritability in broad sense} \)
\( \sigma_p = \text{Phenotypic standard deviation} \)

**Results and Discussion**

The analysis of variance indicated highly significant differences among the genotypes for all the traits studied (Table 2). The results revealed that the values of PCV were higher than the GCV values but the difference between PCV and GCV were very low indicating these characters are less influenced by environment.

The study of genetic parameters in 32 cucumber genotypes revealed the presence of large amount of variation (Fig. 1). Maximum amount of variability was recorded for characters *viz.*, total yield per plant (1.67 to 6.49 kg), average fruit weight (203.67 to 1088.13 g), fruit length (4.74 to 26.69 cm) presented in Table 2 indicating the scope for selection of suitable initial breeding material for further improvement. The results are in accordance with the reports of Kumar *et al.*, (2011) in cucumber.

The estimates of PCV and GCV were high (> 20%) for characters (Table 3) such as number of primary branches per plant (36.91%, 36.40%), node number at which first female flower appears (36.78%, 23.92%), fruit length (45.60%, 29.23%), fruit weight (36.13%, 23.72%), number of seeds per fruit (30.06%, 28.32%), 100 seed weight (42.58%, 40.01%), total soluble solids (24.64%, 23.61%), carotenoids (66.91%, 62.09%), acidity (48.84%, 46.39%), ascorbic acid (25.16%, 23.84), aphid incidence (122.11%, 119.51%), powdery mildew incidence (53.17%, 51.83%) and fruit yield per vine (38.45%, 36.04%).

High PCV and GCV values indicate large amount of variation and consequently more scope for their improvement through selection. The higher the GCV, the more will be the chance for exploitation of that particular character in a selection programme. These findings are in agreement with Veena *et al.*, (2012).

**Heritability**

The estimates of heritability (Table 4.10) were high (>60%) for vine length (60.66%), number of primary branches per plant (97.2%), days to first male flowering (89.9%), days to first female flowering (92.4%), days to 50% male flowering (95.9%), days to 50% female flowering (95.7%), days to first fruit harvest (95.1%), number of seeds per fruit (88.8%), total soluble solids (91.8%), carotenoids (86.1%), acidity (90.2%), ascorbic acid (89.8%), aphid
incidence (95.8%), powdery mildew incidence (95.0%) and fruit yield per vine (87.8%). Similar findings were reported by Tomar et al., 2008 in cucumber. As per the above results, it can be concluded that direct selection based on these characters will be promising.

The estimates for genetic advance as percent of mean (Table 3) were high (>20%) for number of primary branches per plant (73.93%), days to first male flowering (23.67%), days to first female flowering (22.34%), days to 50% male flowering (23.22%), days to 50% female flowering (24.07%), days to first fruit harvest (22.52%), days to last fruit harvest (21.12%), inter nodal length (21.90%), node number at which first female flower appears (32.04%), fruit length (38.59%), fruit diameter (24.41%), fruit weight (32.07%), number of seeds per fruit (54.97%), 100 seed weight (77.44%), total soluble solids (46.60%), carotenoids (118.69%), acidity (90.78%), ascorbic acid (46.52%), aphid incidence (240.96%), powdery mildew incidence (104.09%) and fruit yield per vine (69.57%). Characters showing high value of GAM indicate the role of additive gene action and hence selection is more effective for such characters. These findings are agreement with Chikezie et al., 2015 in cucumber.

Johnson et al., (1955) reported that high heritability along with high genetic gain was more efficient and dependable in predicting the improvement through selection. Characters like primary branches per plant, days to first male flowering, days to first female flowering, days to 50% male flowering, days to 50% female flowering, days to first fruit harvest, days to last harvest, number of seeds per fruit, TSS, carotenoids, acidity, ascorbic acid and fruit yield per vine recorded high heritability accompanied with high genetic advance. Thus, the expression of these traits is predominantly governed by additive gene effects and therefore selection based on phenotypic performance will be useful to improve these characters in future as suggested by Chandrashekhar et al., (2006).

The characters viz., number of primary branches per plant, number of seeds per fruit, carotenoids, TSS, acidity, ascorbic acid and fruit yield were observed with high genetic variability, high heritability in conjunction with high genetic advance as percent mean indicating the predominance of additive gene action on the expression of these traits and hence direct selection will be rewarding for improvement of these traits in cucumber.

Genetic divergence

The genetic diversity for 32 genotypes of cucumber were assessed quantitatively for yield, yield related attributes, aphid and powdery mildew incidence by employing Mahalonobis D² statistics. Tocher’s method (Rao, 1952) was used to group 32 cucumber genotypes into six clusters by treating estimated D² values as the square of the generalized distance.

The intra and inter cluster D² values among 6 clusters were presented given in Table 4. The inter cluster D² value is the main criterion for selection of genotypes. The genotypes belonging to cluster VI and V (622.52), followed by cluster IV and III (591.45) are genetically more divergent and selection of parents from these diverse clusters for hybridization programme would help in achieving novel recombinants in cucumber.

A wide range of variation was registered in the cluster means for most of the characters studied. Cluster VI ranked first with respect to the desirable characters viz., number of fruits per plant, fruit length fruit diameter and fruit yield per vine.
Table 1 List of cucumber genotypes along with their sources

| S. No | Genotypes | Accession No | Source/Place            |
|-------|------------|--------------|-------------------------|
| 1.    | A1         | SKY 613476   | NBPGR, Thrissur, Kerala |
| 2.    | A2         | SKY 613477   | NBPGR, Thrissur, Kerala |
| 3.    | A3         | SKY 613479   | NBPGR, Thrissur, Kerala |
| 4.    | A4         | SKY 613480   | NBPGR, Thrissur, Kerala |
| 5.    | A5         | SKY 613481   | NBPGR, Thrissur, Kerala |
| 6.    | A6         | SKY 613484   | NBPGR, Thrissur, Kerala |
| 7.    | A7         | SKY 613485   | NBPGR, Thrissur, Kerala |
| 8.    | A8         | KP613474     | NBPGR, Thrissur, Kerala |
| 9.    | A9         | JJK 595518   | NBPGR, Thrissur, Kerala |
| 10.   | A10        | JS541367     | NBPGR, Thrissur, Kerala |
| 11.   | A11        | JR469517     | NBPGR, Thrissur, Kerala |
| 12.   | A12        | JB595504     | NBPGR, Thrissur, Kerala |
| 13.   | A13        | JB8613462    | NBPGR, Thrissur, Kerala |
| 14.   | A14        | JB613488     | NBPGR, Thrissur, Kerala |
| 15.   | A15        | JB595508A    | NBPGR, Thrissur, Kerala |
| 16.   | A16        | JB613470     | NBPGR, Thrissur, Kerala |
| 17.   | A17        | JB595510     | NBPGR, Thrissur, Kerala |
| 18.   | A18        | JB618083     | NBPGR, Thrissur, Kerala |
| 19.   | A19        | JB595512     | NBPGR, Thrissur, Kerala |
| 20.   | A20        | JB 618084    | NBPGR, Thrissur, Kerala |
| 21.   | A21        | IC 567558-2  | NBPGR, Jodhpur, Rajasthan |
| 22.   | A22        | IC 321367    | NBPGR, Jodhpur, Rajasthan |
| 23.   | A23        | IC 567558-3  | NBPGR, Jodhpur, Rajasthan |
| 24.   | A24        | IC 321370    | NBPGR, Jodhpur, Rajasthan |
| 25.   | A25        | IC 567558-4  | NBPGR, Jodhpur, Rajasthan |
| 26.   | A26        | IC 321375    | NBPGR, Jodhpur, Rajasthan |
| 27.   | A27        | IC 567558-1  | NBPGR, Jodhpur, Rajasthan |
| 28.   | A28        | IC 567558-5  | NBPGR, Jodhpur, Rajasthan |
| 29.   | A29        | IC 321379    | NBPGR, Jodhpur, Rajasthan |
| 30.   | A30        | IC 550207    | NBPGR, Jodhpur, Rajasthan |
| 31.   | A31        | ICPCHI       | F1 Hybrid               |
| 32.   | A32        | Multistar    | RZ F1                   |
|       |            | RijkZwaan    |                         |
**Table 2** Analysis of variance for various horticultural traits in cucumber

| S. No | Parameters                              | Source of variance |
|-------|-----------------------------------------|--------------------|
|       |                                         | Genotypes | Replications | Errors | Total  |
|       |                                         | df        |             |        |        |
| 1.    | Vine Length (cm)                        | 31        | 2           | 62     | 95     |
| 2.    | Number of primary branches per plant    | 63.54**   | 5.61        | 21.38  | 90.53  |
| 3.    | Inter nodal length (cm)                 | 21.52**   | 0.23        | 4.84   | 26.59  |
| 4.    | Number of nodes per vine                | 6.81**    | 2.21*       | 1.76   | 10.78  |
| 5.    | Node number at which first female flower appears | 13.68** | 0.32        | 4.28   | 18.28  |
| 6.    | Days to first male flowering            | 108.13**  | 1.61        | 3.90   | 113.63 |
| 7.    | Days to first female flowering          | 110.49**  | 7.53        | 2.94   | 120.95 |
| 8.    | Days to 50% male flowering              | 103.92**  | 0.15        | 1.45   | 105.52 |
| 9.    | Days to 50% female flowering            | 110.47**  | 11.83       | 4.30   | 126.59 |
| 10.   | Days to first fruit harvest             | 164.12**  | 0.64        | 2.39   | 167.15 |
| 11.   | Days to last fruit harvest              | 212.08**  | 0.01        | 3.57   | 215.66 |
| 12.   | Number of fruits per plant              | 1.39**    | 0.08        | 0.42   | 1.89   |
| 13.   | Fruit length (cm)                       | 128.33**  | 2.19*       | 41.51  | 172.03 |
| 14.   | Fruit diameter (cm)                     | 6.12**    | 1.22*       | 1.64   | 8.98   |
| 15.   | Fruit weight (gm)                       | 92588.98**| 10179.93**  | 28302.4| 131071.3|
| 16.   | Number of seeds per fruit               | 17336.29**| 407.19**    | 700.82 | 18444.30|
| 17.   | 100 Seed weight (gm)                    | 1.84**    | 0.05        | 0.08   | 1.97   |
| 18.   | TSS (°Brix)                             | 1.49**    | 0.01        | 0.04   | 1.54   |
| 19.   | Carotenoids (µg/100 gm)                 | 0.02**    | 0.00        | 0.00   | 0.03   |
| 20.   | Acidity (%)                             | 0.07**    | 0.01        | 0.00   | 0.08   |
| 21.   | Ascorbic Acid (mg/100 gm fresh fruit weight) | 1.54** | 0.00        | 0.06   | 1.60   |
| 22.   | Aphids incidence                        | 1273.6**  | 47.58       | 183.06 | 1297.3 |
| 23.   | Powdery mildew incidence                | 2112.00*  | 4.63        | 36.11  | 2152.73|
| 24.   | Fruit yield (kg/vine)                   | 4.22**    | 0.17        | 0.19   | 4.57   |

**Significant at 5% level, *significant at 1% level**
Table 3: Estimates of variability, heritability and genetic advance as percent of mean for 24 characters in cucumber

| S. No | Parameters                                           | General Mean | Variance | Coefficient of variation | Heritability (Broad sense %) | Genetic advance @ 5% | GAM @ 5% |
|-------|------------------------------------------------------|--------------|----------|--------------------------|-----------------------------|----------------------|-----------|
| 1     | Vine Length (cm)                                     | 214.45       | 58.5     | 64.5                     | 6.35                        | 5.15                 | 60.66     | 26.5     | 12.35    |
| 2     | Number of primary branches per plant                | 4.06         | 2.18     | 2.24                     | 36.40                       | 36.91                | 97.2      | 3.00     | 73.93    |
| 3     | Inter nodal length (cm)                             | 16.21        | 5.56     | 10.40                    | 14.54                       | 19.89                | 53.5      | 3.55     | 21.90    |
| 4     | Number of nodes per vine                            | 12.79        | 1.68     | 3.44                     | 10.14                       | 14.51                | 48.8      | 1.87     | 14.59    |
| 5     | Node no. at which first female flower appears       | 7.40         | 3.14     | 7.41                     | 23.92                       | 36.78                | 42.3      | 2.37     | 32.04    |
| 6     | Days to first male flowering                        | 48.64        | 34.74    | 38.64                    | 12.12                       | 12.78                | 89.9      | 11.51    | 23.67    |
| 7     | Days to first female flowering                      | 53.08        | 35.85    | 38.79                    | 11.28                       | 11.73                | 92.4      | 11.86    | 22.34    |
| 8     | Days to 50% male flowering                          | 50.77        | 34.15    | 35.61                    | 11.51                       | 11.75                | 95.9      | 11.79    | 23.22    |
| 9     | Days to 50% female flowering                        | 48.08        | 35.39    | 39.69                    | 12.37                       | 13.10                | 89.2      | 11.57    | 24.07    |
| 10    | Days to first fruit harvest                         | 65.71        | 53.91    | 56.30                    | 11.17                       | 11.42                | 95.7      | 14.80    | 22.52    |
| 11    | Days to last fruit harvest                          | 79.32        | 69.50    | 73.07                    | 10.51                       | 10.78                | 95.1      | 16.75    | 21.12    |
| 12    | Number of fruits per plant                          | 5.12         | 0.32     | 0.75                     | 11.12                       | 16.85                | 43.5      | 0.77     | 15.11    |
| 13    | Fruit length (cm)                                   | 18.41        | 28.94    | 70.45                    | 29.23                       | 45.60                | 41.1      | 7.10     | 38.59    |
| 14    | Fruit diameter (cm)                                 | 7.12         | 1.49     | 3.13                     | 17.17                       | 24.87                | 47.6      | 1.74     | 24.41    |
| 15    | Fruit weight (gm)                                   | 617.20       | 21428.86 | 49731.26                | 23.72                       | 36.13                | 43.1      | 197.95   | 32.07    |
| 16    | Number of seeds per fruit                           | 262.96       | 5545.16  | 6245.98                  | 28.32                       | 30.06                | 88.8      | 144.54   | 54.97    |
| 17    | 100 Seed weight (gm)                                | 1.92         | 0.59     | 0.67                     | 40.01                       | 42.58                | 88.3      | 1.48     | 77.44    |
| 18    | TSS (O.Brix)                                        | 2.94         | 0.48     | 0.52                     | 23.61                       | 24.64                | 91.8      | 1.37     | 46.60    |
| 19    | Carotenoids micro gm/100 gm                         | 0.14         | 0.01     | 0.01                     | 62.09                       | 66.91                | 86.1      | 0.17     | 118.69   |
| 20    | Acidity (%)                                         | 0.33         | 0.02     | 0.03                     | 46.39                       | 48.84                | 90.2      | 0.30     | 90.78    |
| 21    | Ascorbic Acid (mg/100 gm fresh fruit weigh)         | 2.95         | 0.49     | 0.55                     | 23.84                       | 25.16                | 89.8      | 1.37     | 46.52    |
| 22    | Aphids incidence                                    | 541.30       | 418500.84| 436873.91               | 119.51                      | 122.11               | 95.8      | 1304.32  | 240.96   |
| 23    | Powdery mildew incidence                            | 50.75        | 691.96   | 728.07                   | 51.83                       | 53.17                | 95.0      | 52.83    | 104.09   |
| 24    | Fruit yield (kg/vine)                               | 3.22         | 1.34     | 1.53                     | 36.04                       | 38.45                | 87.8      | 2.24     | 69.57    |
Table. 4 Average intra and inter cluster D2 values of cucumber genotypes

| Cluster | I   | II  | III  | IV   | V    | VI |
|---------|-----|-----|------|------|------|----|
| I       | 88.25 (9.39) | 196.98 (14.03) | 454.74 (21.32) | 187.69 (13.70) | 452.50 (21.27) | 517.70 (22.75) |
| II      | 125.73 (11.21) | 258.77 (16.09) | 289.84 (17.02) | 298.35 (17.27) | 404.27 (20.11) |
| III     | 60.34 (7.77) | 591.45 (24.32) | 518.64 (22.77) | 415.66 (20.39) |
| IV      | 180.69 (13.44) | 507.42 (22.53) | 453.65 (21.30) |
| V       | 0.00 (0.00) | 622.52 (24.95) |
| VI      | 0.00 (0.00) |

**Fig.1** Phenotypic and genotypic coefficient of variation, Heritability, genetic advance for different characters in cucumber
The same cluster also recorded lower mean value for powdery mildew incidence. Cluster III ranked first for earliness characters like days to first female flowering, days to 50% female flowering and days to first fruit harvest, besides having ideal quality characters like maximum cluster mean value for carotenoids. Hence genotypes belonging to the clusters VI and III are amenable for exploitation in future crop improvement of cucumber.

In conclusion, cucumber genotypes exhibited high variability for most of the traits like plant growth characters, fruit characters, quality and seed characters. On the basis of mean performance of the genotypes studied, in terms of earliness, yield and quality traits, the genotypes viz., A10 (JS 541367), A12 (JB 595504), A22 (IC 321367) and A30 (IC 550207) were found superior and were identified as promising lines for further crop improvement in cucumber. These genotypes belong to the clusters VI and III which are genetically divergent and hybridization between these genotypes will likely produce desirable segregants.

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