Diversity in Cucumber (Cucumis sativus L.) Genotypes Based on Morphological Yield Traits with Protein Profiling

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Authors’ contributions
This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT
In this research, fortyfour genotypes with two check varieties of cucumber (Cucumis sativus L.) were studied that were collected from different geographical regions of India. Biodiversity is one of the most important factors in the survival and improvement of any species. Therefore, germplasm collection is the first step for plant improvement. To investigate their genetic and morphological relationships morphological traits of genotypes of cucumbers were evaluated with check varieties. We found that the traits, the total yield varied during first season from 48.80-144.48 (q/ha) with average of 89.81 (q/ha). During second season, it varied from 46.30-202.00 (q/ha) with an average of 104.90 (q/ha). The single fruit weight varied during first season from 182.98 to 371.87 gm. with average of 287.89 gm. During second season, it varied from 180.16 to 380.11 gm. with an average of 281.75 gm. Fruit length varied during first season from 6.43 to 25.28 cm. with average of 16.22 cm. During second season, it varied from 6.06 to 25.26 cm. with an average of 16.25 cm. The number of fruits per plant varied during first season from 3.30-8.30 with average of 5.60. During second season, it varied from 2.80-10.56 with an average of 6.69. The distinct genotypes found in this study based on morpho-molecular characters will great interest to cucumber breeder for selection of diverse parent or production of mapping population.

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1. INTRODUCTION

Cucumbers (2n=2x=14), belonging to the Cucurbitaceae family, are one of the most imperative vegetables [1]. They can be used in salads or in processed forms (pickled, salty). The primary origins of diversity cucumber varieties have reported India [2]. Cucumber is believed to have been domesticated in India for 3000 years and in Eastern Iran and China probably for 2000 years. Improvement of crop depends on the magnitude of genetic variability in economic traits, therefore, the evaluation and utilization of genetic variability in desired direction becomes extremely important in any yield improvement programme. The extent of genetic variability in a specific breeding population depends on the genotypes included in it and its selection history [3-7]. In this regard, it is necessary to survey the available useful variability and nature of association among the various plant characters. The phenotypic expression of the plant characters is mainly controlled by the genetic makeup of the plant and the environment, in which it is growing [6-10]. Additional the genetic variance of some quantitative trait is collected of additive variance (heritable) and non-additive variance and comprise dominance and epistasis (non-allelic interaction). Therefore, it becomes necessary to partition the observed phenotypic variability into its heritable and non-heritable components with suitable parameters such as phenotypic and genotypic coefficient of variation, heritability and genetic advance.

2. MATERIALS AND METHODS

The mean relative humidity remained almost 60-80% by the third week of April to Second week of June and then there is an increase in relative humidity from last week of June to October i.e. 80-90 %. Frost can be expected from last week of December to end of February. The weekly averages of various weather parameters that prevailed during the course of investigation recorded at the meteorological Observatory of N.E. Borlaug Crop Research Centre of the university are presented. The present investigation was conducted with two season during July-October, 2014 and February-June, 2015 at Vegetable Research Centre, Department of Vegetable Science in G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The materials for the present thesis research experiment are listed in Table 1.

2.1 Experimental Materials

The main experimental material for the present study comprised of 46 divergent genetic stock of cucumber including two checks as collected from different part of country maintained in the Department of Vegetable Science, G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand. The materials for the present thesis research experiment are listed in Table 1.

2.2 Agro Climatic Conditions

Agro Climatic Conditions the climate of Pantnagar is humid Sub-Tropical with maximum temperature raging from 32°C to 42°C in summer and minimum temperature raging from 3°C to 14°C in winter. The monsoon generally Starts from the third week of June and recedes by the end of September.

Table 1 Average weekly meteorological data during cropping period from July 2014- Oct. 2014 and Feb. 2015–June 2015.
Table 1. List and source of various genotypes of cucumbers

| S.L. No | Genotypes     | Source                         |
|---------|---------------|--------------------------------|
| 1.      | PCUC-199      | Saung, Tehari, U.K.            |
| 2.      | PCUC-832      | Mukhautia, Raibareilly, U.P.   |
| 3.      | PCUC-44       | Palampur, H.P.                 |
| 4.      | PCUC-23       | Kanatal, Tehari, U.K.          |
| 5.      | PCUC-104      | Kanatal, Tehari, U.K.          |
| 6.      | PCUC-193      | Ghosi, Mau, U.P.               |
| 7.      | PCUC-4302     | Sultanpur, U.P.                |
| 8.      | PCUC-26       | Aashapur Varanasi, U.P.        |
| 9.      | PCUC-83       | Faridpur, Bareilly, U.P.       |
| 10.     | PCUC-08       | Ghosi, Mau, U.P.               |
| 11.     | PCUC-202      | Hanuman ganj, Allahabad, U.P.  |
| 12.     | PCUC-25       | Chumal, Champawat, U.K.        |
| 13.     | Euc-1-07      | Chumal, Champawat, U.K.        |
| 14.     | PCPGR-04      | Palampur HP                    |
| 15.     | PCPGR-06      | Jammu, Kasmir                  |
| 16.     | PCPGR-07      | Jammu, Kasmir                  |
| 17.     | PCPGR-13      | Palampur, H.P.                 |
| 18.     | PCPGR-15      | Baruasagar, Jhansi, U.P.       |
| 19.     | PCPGR-19      | Chumal, Champawat, U.K.        |
| 20.     | PCPGR-20      | Chetia, Siddartha Nagar, U.P.  |
| 21.     | PCPGR-21      | NBPG, New Delhi                |
| 22.     | PCPGR-22      | Baruasagar, Jhansi, U.P.       |
| 23.     | PCPGR-24      | Sikandrabad, Bulandshahar, U.P.|
| 24.     | PCPGR-29      | Rampur, U.P.                   |
| 25.     | PCPGR-34      | Bharatipur, Jabalpur, MP       |
| 26.     | PCPGR-45      | Givathkapurawa, Faizabad, U.P. |
| 27.     | PCPGR-103     | Sekha, Aligarh, U.P.           |
| 28.     | PCPGR-138     | Chetia, Siddartha Nagar, U.P.  |
| 29.     | PCPGR-196     | JaipurPady, Nainital, U.K.     |
| 30.     | PCPGR-264     | Kalyanismadarasa, Faizabad, U.P. |
| 31.     | PCPGR-748     | Sultanpur, U.P.                |
| 32.     | PCPGR-4343    | Sultanpur, U.P.                |
| 33.     | PCPGR-5370    | Sultanpur, U.P.                |
Table 2. Average weekly meteorological data during cropping period from July 2014- Oct. 2014 and Feb. 2015–June 2015

| Month | Date | Year | Temperature (°C) | Relative Humidity (%) | Rainfall (mm) | Wind (Km./Hr.) | Velocity | Sun Shine Hrs. | Evap.(mm) |
|-------|------|------|------------------|-----------------------|--------------|---------------|-----------|----------------|----------|
|       |      |      | Max.             | Min.                  |              |               |           |                |          |
| Jun   | 19-25| 2014 | 37.6             | 24.1                  | 64           | 34            | 0.0       | 5.5            | 8.5      | 10.7      |
| Jun- July | 26-02 | 2014 | 39.4             | 23.6                  | 67           | 46            | 0.1       | 4.6            | 7.5      | 10.9      |
| July  | 03-09| 2014 | 35.2             | 24.6                  | 85           | 66            | 0.9       | 5.6            | 5.6      | 5.7       |
| July  | 10-16| 2014 | 36.4             | 25.1                  | 87           | 68            | 11.3      | 6.4            | 2.6      | 6.8       |
| July  | 17-23| 2014 | 33.4             | 24.3                  | 89           | 64            | 0.48      | 6.4            | 2.6      | 6.9       |
| July  | 24-31| 2014 | 34.1             | 23.2                  | 90           | 64            | 0.365     | 6.7            | 3.8      | 10.2      |
| August| 01-07| 2014 | 35.6             | 25.4                  | 89           | 63            | 0.54      | 5.6            | 6.5      | 7.6       |
| August | 08-14 | 2014 | 34.6             | 24.3                  | 86           | 64            | 0.34      | 4.9            | 5.4      | 5.4       |
| August | 15-21 | 2014 | 35.4             | 24.6                  | 91           | 68            | 0.0       | 6.5            | 7.2      | 6.4       |
| August | 22-28| 2014 | 37.1             | 25.4                  | 86           | 59            | 0.13      | 7.2            | 3.4      | 7.2       |
| Aug.-Sep. | 29-04 | 2014 | 35.1             | 25.1                  | 89           | 66            | 0.12      | 6.4            | 5.1      | 7.5       |
| Sep.  | 05-11| 2014 | 34.1             | 24.3                  | 92           | 69            | 0.0       | 7.2            | 4.6      | 5.7       |
| Sep.  | 12-18| 2014 | 33.5             | 24.9                  | 91           | 65            | 0.0       | 6.4            | 8.4      | 6.2       |
| Sep.  | 19-25| 2014 | 34.3             | 23.5                  | 86           | 67            | 0.1       | 7.2            | 4.5      | 3.4       |
| Oct.  | 01-07| 2014 | 32.2             | 22.6                  | 90           | 60            | 5.60      | 2.5            | 4.9      | 3.0       |
| Month       | Date  | Year | Temperature (°C) | Relative Humidity (%) | Rainfall (mm) | Wind Velocity (Km./Hr.) | Sun Shine Hrs. | Evap.(mm) |
|-------------|-------|------|------------------|-----------------------|---------------|-------------------------|----------------|-----------|
| Oct.        | 08-14 | 2014 | 31.4             | 17.9                  | 87            | 55                      | 0.00           | 4.2       | 8.3     | 3.2 |
| Oct.        | 15-21 | 2014 | 29.1             | 15.5                  | 91            | 51                      | 0.00           | 2.5       | 8.7     | 3.1 |
| Oct.        | 22-28 | 2014 | 29.3             | 16.6                  | 88            | 55                      | 0.00           | 1.7       | 3.9     | 2.4 |
| Oct.-Nov.   | 29-04 | 2014 | 28.5             | 13.5                  | 91            | 46                      | 0.00           | 1.9       | 5.6     | 2.7 |
| Nov.        | 05-11 | 2014 | 29.2             | 12.8                  | 91            | 46                      | 0.00           | 2.8       | 8.2     | 2.5 |
| Jan.-Feb.   | 29-04 | 2015 | 20.2             | 8.1                   | 89            | 62                      | 0.00           | 0.6       | 5.1     | 1.7 |
| Feb.        | 05-11 | 2015 | 22.3             | 7.4                   | 94            | 54                      | 0.00           | 3.5       | 7.1     | 2.3 |
| Feb.        | 12-18 | 2015 | 23.7             | 9.8                   | 88            | 51                      | 0.00           | 3.5       | 4.6     | 1.9 |
| Feb.        | 19-25 | 2015 | 27.1             | 13.4                  | 90            | 55                      | 7.00           | 4.1       | 4.8     | 2.4 |
| Feb.-March  | 26-04 | 2015 | 22.8             | 13                    | 92            | 61                      | 61.1           | 6.2       | 5.2     | 2.6 |
| March       | 05-11 | 2015 | 25.8             | 10.2                  | 89            | 45                      | 0.00           | 5.5       | 8.3     | 2.8 |
| March       | 12-18 | 2015 | 26.8             | 12.7                  | 90            | 51                      | 1.20           | 5.3       | 6.8     | 3.0 |
| March       | 19-25 | 2015 | 30.4             | 13.7                  | 88            | 45                      | 0.00           | 4.1       | 9.6     | 3.7 |
| March-April | 26-01 | 2015 | 30.9             | 17.7                  | 86            | 44                      | 26.2           | 5.5       | 7.4     | 4.1 |
| April       | 02-08 | 2015 | 29.4             | 15.0                  | 89            | 45                      | 18.9           | 4.8       | 6.9     | 4.1 |
| April       | 09-15 | 2015 | 31.9             | 16.6                  | 82            | 36                      | 0.00           | 4.9       | 7.7     | 4.9 |
| April       | 16-22 | 2015 | 35.3             | 18.5                  | 74            | 35                      | 0.00           | 6.0       | 8.7     | 6.1 |
| April       | 23-29 | 2015 | 37.7             | 19.2                  | 65            | 34                      | 0.20           | 8.8       | 9.0     | 7.3 |
| April- May  | 30-06 | 2015 | 35.4             | 18.3                  | 70            | 29                      | 18.8           | 5.7       | 10.4    | 7.4 |
| May         | 7-13  | 2015 | 37.9             | 24.5                  | 69            | 39                      | 09.0           | 6.7       | 08.7    | 7.5 |
| May         | 14-20 | 2015 | 36.8             | 22.5                  | 70            | 37                      | 001.8          | 6.5       | 10.7    | 7.6 |
| May         | 21-27 | 2015 | 41.1             | 22.5                  | 67            | 31                      | 000.9          | 6.7       | 09.4    | 7.8 |
| May-Jun     | 28-03 | 2015 | 39.6             | 22.2                  | 63            | 31                      | 000.0          | 6.3       | 08.3    | 9.3 |
| Jun         | 04-10 | 2015 | 40.9             | 24.5                  | 62            | 30                      | 000.0          | 7.8       | 09.7    | 10.6 |
| Jun         | 11-17 | 2015 | 38.0             | 25.5                  | 62            | 38                      | 000.8          | 8.8       | 07.4    | 10.7 |
| Jun         | 18-24 | 2015 | 35.1             | 26.5                  | 73            | 53                      | 072.2          | 7.2       | 06.2    | 6.4 |
| Jun- July   | 25-01 | 2015 | 32.0             | 23.8                  | 90            | 76                      | 324.8          | 8.5       | 05.0    | 5.5 |
3. RESULTS AND DISCUSSION

3.1 Estimation of Variability

The general mean and range of variation for different character are given in Table 2.

Days to first male flower: Days to first male flower varied during first season from 28.87 days to 47.43 days with average of 38.13 days. During second season, it varied from 31.76 days to 51.13 days with an average of 41.13 days. Pooled analysis of tow season data showed that the first male flower was varied from 30.32 days to 46.68 days with an average of 39.62. Node number to first male flower: Node number to first male flower varied during fist season from 2.33 to 7.66 nodes with average of 5.39 nodes. During second season, it varied from 2.33 nodes to 7.66 nodes with an average of 5.44 nodes. Pooled analysis of tow season data showed that the node number to first male flower varied from 3.33 nodes to 7.50 nodes with an average of 5.42. Days to first female flower: Days to first female flowers varied during fist season from 35.19-52.30 days with average of 43.27 days. During second season, it varied from 30.76- 55.70 days with an average of 46.05 days. Pooled analysis of both season data showed that the days to first female flower was varied from 33.78-53.35 days with an average of 44.66. Node number to first female flower: Node number to first male flower varied during first season from 7.00-11.00 nodes with average of 7.03 nodes. During second season, it varied from 1.00- 9.00 nodes with an average of 7.04 nodes. Pooled analysis of both season data showed that the node to first female flower was varied from 2.33-9.50 nodes with an average of 7.04. Internodal length (cm): The Internodal length varied during first season from 4.00-8.00 cm. with average of 6.03 cm. During second season, it varied from 4.28-15.73 cm. with an average of 10.23 cm.

Pooled analysis of both season data showed that the Internodal length was varied from 4.62-11.27 cm. with an average of 8.13 cm. Days to first fruit harvest: Days to first fruit harvest varied during first season from 29.46 days to 49.80 days with average of 38.03 days. During second season, it varied from 35.48 days to 67.35 days with an average of 49.41 days.

Pooled analysis of both season data showed that the days to first fruit harvest was varied from 35.01 days to 55.05 days with an average of 43.72 days. Number of fruits per plant: The number of fruits per plant varied during first season from 3.30-8.30 with average of 5.60. During second season, it varied from 2.80-10.56 with an average of 6.69. Pooled analysis of both season data showed that the number of fruits per plant were varied from 4.00-8.78 with an average of 6.15.

Fruit length (cm): Fruit length varied during first season from 6.43 to 25.28 cm. with average of 16.22 cm. During second season, it varied from 6.06 to 25.26 cm. with an average of 16.25 cm. Pooled analysis of both season data showed that the fruit length was varied from 6.42 to 23.68 cm. with an average of 16.24 cm. Fruit diameter (cm): The fruit diameter varied during first season from 2.25-8.57 cm. with average of 3.87 cm. During second season, it varied from 2.24- 5.14 cm. with an average of 3.50 cm.

Pooled analysis of both season data showed that the fruit diameter was varied from 2.44-5.48 cm. with an average of 3.69 cm. Fruit weight (g): The single fruit weight varied during first season from 182.98 to 371.87 gm. with average of 287.89 gm. During second season, it varied from 180.16 to 380.11 gm. with an average of 281.75 gm.

Pooled analysis of both season data showed that the fruit weight was varied from 181.57 to 355.73 gm. with an average of 284.82 gm. Test weight (gm.): Test weight varied during first season from 10.73-27.48 gm. with average of 20.03 gm. During second season, it varied from 19.50-40.70gm with an average of 31.86 gm.. Pooled analysis of both season data showed that the test weight was varied from 17.43-30.19 cm. with an average of 25.95 gm. Seed Index (gm.): The seed index varied during fist season from 1.61-5.65 gm. with average of 3.18 gm. During second season, it varied from 2.10- 4.59gm. With an average of 3.35 gm. Pooled analysis of both season data showed that the seed index as varied from 2.42-4.90 cm. with an average of 3.27 gm. Primary branches/Plant: The total number of primary branches per plant varied during first season from 3.00 to 7.66 with average of 5.33.

During second season, it varied from 2.00 to 7.66with an average of 4.80. Pooled analysis of both season data showed that the primary branches per plant was varied from 3.50 to 6.66 with an average of 5.07. Plant height (m): Plant height varied during first season from 1.33-3.80 meter with average of 2.15 m.

During second season, it varied from 1.16- 3.66 m with an average of 2.33 m. Pooled analysis of
| S. No. | Characters                        | First season | Second season | Pooled     |
|--------|----------------------------------|--------------|---------------|------------|
|        |                                  | General mean | Range         | General mean | Range     | General mean | Range     |
| 1.     | Days to first male flowers       | 38.13        | 28.87-47.43   | 41.11       | 31.76-51.13 | 39.62        | 30.32-46.68 |
| 2.     | Node number to first male flower | 5.39         | 2.33-7.66     | 5.44        | 2.33-7.66   | 5.42         | 3.33-7.50  |
| 3.     | Days to first female flowers     | 43.27        | 35.19-52.30   | 46.05       | 30.76-55.70 | 44.66        | 33.78-53.35 |
| 4.     | Node number to first female flower | 7.03       | 3.00-11.00    | 7.04        | 1.00-9.00   | 7.04         | 2.33-9.50  |
| 5.     | Internodal length (cm)           | 6.03         | 4.00-8.00     | 10.23       | 4.28-15.73  | 8.13         | 4.62-11.27 |
| 6.     | Days to first fruit harvest      | 38.03        | 29.46-49.80   | 49.41       | 35.48-67.35 | 43.72        | 35.01-55.05 |
| 7.     | Number of fruits per plant       | 5.60         | 3.30-8.30     | 6.69        | 2.80-10.56  | 6.15         | 4.00-8.78  |
| 8.     | Fruit length (cm)                | 16.22        | 6.43-25.28    | 16.25       | 6.06-25.26  | 16.24        | 6.42-23.68 |
| 9.     | Fruit diameter (cm)              | 3.87         | 2.25-8.57     | 3.50        | 2.24-5.14   | 3.69         | 2.44-5.48  |
| 10.    | Fruit weight (g)                 | 287.89       | 182.98-371.87 | 281.75      | 180.16-380.11 | 284.82       | 181.57-355.73 |
| 11.    | Test weight (gm.)                | 20.03        | 10.73-27.48   | 31.86       | 19.50-40.70 | 25.95        | 17.43-30.19 |
| 12.    | Seed index (gm.)                 | 3.18         | 1.61-5.65     | 3.35        | 2.10-4.59   | 3.27         | 2.42-4.90  |
| 13.    | Primary branches/ Plant          | 5.33         | 3.00-7.66     | 4.80        | 2.00-7.66   | 5.07         | 3.50-6.66  |
| 14.    | Plant height (m.)                | 2.15         | 1.33-3.80     | 2.33        | 1.16-3.66   | 2.24         | 1.47-3.20  |
| 15.    | Yield (q/ha)                     | 89.81        | 48.80-144.48  | 104.90      | 46.30-202.00 | 97.35        | 60.56-173.24 |
Electrophoresis File 1
Electrophoresis File 2
Electrophoresis File 3
Electrophoresis File 4
Electrophoresis File 5

Sample 1

Sample 2

Sample 3

Sample 4

Sample 5

Sample 6
both season data showed that the plant height (m.) was varied from 1.47-3.20 meter with an average of 2.24 m. Yield (q/ha).

The total yield varied during first season from 48.80-144.48 (q/ha) with average of 89.81(q/ha). During second season, it varied from 46.30-202.00 (q/ha) with an average of 104.90 (q/ha). Pooled analysis of two season data showed that the yield was varied from 60.56-173.24 (q/ha) with an average of 97.35 (q/ha).

The SDS solubilized protein samples were then subjected to vertical SDS-PAGE with 12% separating and 5% stacking gels using Tris-glycine electrode buffer (Tris-glycine and SDS, pH-8.6). The samples were electrophoresed at 80V initially and increased by 100V and current 500mA, when the tracking dye passed from the stacking gel. The run was stopped when the dye was approximately 0.5 cm from the bottom of the gel, which took around 4 to 5 hours. The gel was removed with the help of spatula and dipped for 12 hours in staining solution (0.25 g Coomassie Brilliant Blue R-250, 60 g TCA, 180 ml methanol; and 60 ml glacial acetic acid). The staining solution was then replaced the next day with destaining solution (3 % NaCl). The protein profile and zymogram of banding pattern are given in respective plate 1, 2, 3, 4 and 5 with total 46 samples. The protein was divided into three zones A, B, C and each zone was allocated with a number of subzones. Zone A was nearest to origin and comprises protein bands of high molecular weight while C was the farthest from origin and thus had protein bands of low molecular weight. A standard medium range protein molecular weight marker of known molecular weight (5 to 80 KDa) was used along with the samples. For genotype discrimination the presence and absence of protein bands, their thickness, width (Dark, Medium and Light) was the criteria for characterization of germplasm differentiation.

4. CONCLUSION

The study aimed to highlights the genetic and morphological relationships based on morphological traits of genotypes of cucumbers. The extent of genetic variability in a specific breeding population depends on the genotypes included in it and its selection history. The distinct genotypes found in this research based on morpho-molecular characters will great interest to cucumber breeder for selection of diverse parent or production of mapping population.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Jeffery C. A review of the Cucurbitaceae. Botanical Journal of the Linnaean Society. 1980;81:233-247.
2. Wehner, Todd C, Robinson, Richard W. A brief history of the development of cucumber cultivars in the U.S. CGC. 1991; 14:1-4.
3. Arunkumar KH, Ramanjinapa V, Ravishankar M. Path coefficient analysis in F2 population of cucumber (Cucumis sativus L.). Plant Archives. 2011;11:471-74.
4. Arus P. Genetic purity of commercial seed lots. In. S.D. Tanksley and TJ. Orton (eds.). Isozymes on Plant Genetics and Breeding: Part A. Amsterdam, Elsevier Science Publishers. 1983;415-23.
5. Saiki RK, Gelfand DH, Stoffel S, Scharf SJ, Higich R, Horn GT, Mulis KB, Erlich HA. Primer directed enzymatic Amplification of DNA with anthermostable DNA Polymerase. Sci. 1988;239:487-91.
6. Johnson, B.L. and therein, M.M. 1969. Assessment of evolutionary affinities in gossypium by protein electrophoresis. American J. Bot. 57: 1081-92.
7. Daunay MC. Eggplant. In: Vegetables II, Springer, New York, NY. 2008;163-220.
8. Kaushal N, Awasthi R, Gupta K, Gaur P, Siddique KH, Nayyar H. Heatstress-induced reproductive failures in chickpea (Cicer arietinum) are associated with impaired sucrose metabolism in leaves and anthers. Func. Plant Biol. 2013;40:1334-49.
9. Ansari SF, Mehta N, Ansari S, Gavel JP. Research note variability studies in brinjal (Solanum melongena L.) in Chhattisgarh plains. Electronic J. Plant Breed. 2011;2: 275-81.

10. Dadlani, Varier A. Electrophoresis of variety identification. Technical Bulletin. Division of Seed Science and Technology, IARI, New Delhi; 1993.