

Morphometric studies in *Datura metel* Linn

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Abstract. The various forms/varieties of *Datura metel* have so far been distinguished mainly on their morphological characters viz flower colour and number of corolla tubes. This paper deals with morphometric analysis of four forms of *D. metel* considering all sorts of possible morphological characters. The results clearly indicate large variations among the four forms deserving individual taxonomic identity.

Keywords. *D. metel*; Anderson scatter diagram; taxonomic entities.

1. Introduction

Safford (1921) distinguished the varieties of *Datura metel* on the basis of stem and flower colour and the number of corolla tubes. Timmerman (1927a, b) examined the leaves, stomatal numbers and seeds of various *Datura* species. Bessis and Guyot (1976) attempted to use stomatal characters in systematics and phylogenetic studies of Solanaceae. This paper deals with the application of morphometric method in *D. metel* taxonomy for supplementing precise variability in statistical terms to the essential morphological variations.

2. Materials and methods

Four forms of *D. metel* which differ in flower and stem colour, and in number of corolla tubes in the flower were collected from various localities of Saurashtra (Gujarat), Rajasthan, MP and UP. Form 1 is characterised by green stem and simple white infundibuliform flowers. Form 2 bears violet stem and purple flowers with 2–3 corolla tubes, form 3 has dark violet stem and purple flowers with simple corolla tubes and, form 4 has green stem and yellow flowers with 2–4 corolla tubes. All the four forms have been described under *D. metel* in various Indian floras and their identity was further confirmed by the Kew Herbarium. The investigations were carried out during 1979–81. In each form, seeds of one plant were collected to obtain uniformity in morphological characters among the plants of each population. Provenance trials were carried out to delete the temporary variations among the four forms. Measurements were recorded when the plants were 60 days old. Morphological characters were studied qualitatively and quantitatively. In all, 31 characters were measured (table 1). Twenty observations were made for each character for each form. The biostatistical calculations comprised of mean and standard deviation, *t*-test and correlation matrix. Anderson scatter diagrams were prepared to study the trend of diversity among the four forms.

Table 1. Mean and standard deviation of 31 morphological characters in four forms (number of observations 20) of *D. metel*.

| Characters | Form 1 | Form 2 | Form 3 | Form 4 |
|--|--------------|--------------|--------------|--------------|
| Length of largest lateral (cm) | 52.3 ± 13.4 | 76.8 ± 11.5 | 46.8 ± 14.3 | 93.8 ± 3.4 |
| Petiole length of 4th leaf (cm) | 3.9 ± 0.9 | 3.7 ± 0.7 | 2.6 ± 0.4 | 5.7 ± 1.7 |
| Leaf area of 4th leaf (cm ²) | 49.5 ± 12.6 | 52.2 ± 9.8 | 36.9 ± 10.5 | 81.0 ± 25.4 |
| Leaf length/width ratio | 1.0 ± 0.1 | 1.3 ± 0.1 | 1.4 ± 0.1 | 1.5 ± 0.1 |
| Pedicle length (cm) | 0.7 ± 0.2 | 1.3 ± 0.3 | 0.8 ± 0.1 | 1.5 ± 0.2 |
| Calyx length (cm) | 5.9 ± 0.3 | 5.2 ± 0.5 | 5.6 ± 0.8 | 6.8 ± 0.5 |
| Calyx teeth number | 3.3 ± 0.5 | 4.5 ± 0.7 | 4.1 ± 0.5 | 5.0 ± 0.0 |
| Calyx teeth incision (cm) | 1.4 ± 0.2 | 1.3 ± 0.1 | 1.0 ± 0.2 | 1.6 ± 0.2 |
| Corolla length (cm) | 16.3 ± 1.3 | 14.9 ± 1.2 | 12.7 ± 0.8 | 17.2 ± 1.6 |
| Corolla length/Calyx length ratio | 2.7 ± 0.3 | 2.9 ± 0.3 | 2.3 ± 0.4 | 2.5 ± 0.2 |
| Corolla lobes | 5.0 ± 0.0 | 5.4 ± 0.6 | 5.0 ± 0.0 | 5.0 ± 0.2 |
| Acumen number | 5.0 ± 0.0 | 5.5 ± 0.8 | 5.0 ± 0.0 | 5.0 ± 0.2 |
| Acumen length (cm) | 0.6 ± 0.0 | 1.1 ± 0.1 | 0.7 ± 0.1 | 1.4 ± 0.1 |
| Corolla tube length (cm) | 15.3 ± 1.1 | 14.0 ± 1.0 | 12.0 ± 0.8 | 16.0 ± 1.6 |
| Depth of corolla lobing (cm) | 1.0 ± 0.4 | 1.8 ± 0.4 | 0.7 ± 0.2 | 1.1 ± 0.2 |
| Maximum diameter of corolla (cm) | 7.8 ± 1.5 | 6.7 ± 1.5 | 6.1 ± 0.4 | 10.0 ± 1.0 |
| Minimum diameter of corolla (cm) | 3.0 ± 0.6 | 3.8 ± 0.4 | 3.2 ± 0.3 | 5.0 ± 0.4 |
| Stamen number | 5.0 ± 0.0 | 5.2 ± 0.0 | 5.0 ± 0.0 | 5.0 ± 0.0 |
| Stamen length (cm) | 13.2 ± 0.8 | 11.2 ± 0.8 | 10.8 ± 0.8 | 12.6 ± 1.0 |
| Stamenoid number | 0.0 ± 0.0 | 4.2 ± 2.6 | 0.0 ± 0.0 | 0.0 ± 0.0 |
| Anther length | 1.2 ± 0.1 | 1.3 ± 0.1 | 0.9 ± 0.1 | 1.5 ± 0.1 |
| Filament/anther ratio | 10.6 ± 1.2 | 9.0 ± 1.3 | 11.2 ± 1.3 | 8.2 ± 0.7 |
| Adnation of stamen to corolla | 7.8 ± 0.6 | 5.3 ± 0.7 | 6.6 ± 0.6 | 11.2 ± 1.0 |
| Pistil number | 1.0 ± 0.0 | 2.4 ± 1.2 | 1.0 ± 0.0 | 1.0 ± 0.0 |
| Pistil length (cm) | 10.1 ± 1.2 | 11.2 ± 1.0 | 10.1 ± 0.2 | 12.4 ± 1.2 |
| Capsule per plant (average) | 6.6 ± 3.1 | 10.6 ± 4.4 | 6.1 ± 3.2 | 5.0 ± 1.5 |
| Capsule diameter (cm) | 3.5 ± 0.2 | 3.9 ± 1.4 | 3.2 ± 0.3 | 3.4 ± 0.1 |
| Spine length (cm) | 0.2 ± 0.0 | 0.2 ± 0.0 | 0.2 ± 0.0 | 0.2 ± 0.0 |
| Seeds per capsule | 281.0 ± 49.0 | 208.0 ± 12.6 | 133.1 ± 34.7 | 214.8 ± 32.3 |
| Seed width | 0.3 ± 0.0 | 0.3 ± 0.0 | 0.3 ± 0.0 | 0.3 ± 0.0 |
| Seed length | 0.4 ± 0.0 | 0.4 ± 0.0 | 0.4 ± 0.0 | 0.4 ± 0.0 |

With the concept of scatter diagram, populations can be distinguished critically taking any set of characters. The following six sets of morphological characters were chosen to prepare the Anderson scatter diagrams.

(a) Area of 4th leaf *vs* length/width ratio of same leaf. (b) Area of 4th leaf *vs* petiole length of same leaf. (c) Area of 4th leaf *vs* length of corolla tube. (d) Area of 4th leaf *vs* corolla length/calyx length ratio. (e) Corolla/calyx length ratio *vs* length of corolla tube. (f) Corolla/calyx length ratio *vs* length of pistil.

Similarly, student's *t*-test was performed to compare differences between the two means. The test assumes equal variance in the two samples. Each of the 31

morphological characters was critically intercompared in the following sets:

| | |
|---------------|---------------|
| form 1/form 2 | form 2/form 3 |
| form 1/form 3 | form 2/form 4 |
| form 1/form 4 | form 3/form 4 |

Computations were done with IBM 360 at the Physical Research Laboratory, Ahmedabad.

3. Results

3.1 Morphological characters

Table 1 presents the mean and standard deviation of 31 morphological characters in four forms of *D. metel* and shows that the mean value of each quantitative character is specific for each form.

3.2 Anderson scatter diagram

It is evident from figure 1 that all the sets of morphological characters have scattering of points with maximum scattering in four sets (figures 1A, C, D and F). Only in two combinations (figures 1B and E) the groups of points fell on a diagonal line indicating the possibility that although the forms are distinctly separate their genetical stalk could be the same.

3.3 Student's *t*-test

As shown in table 2, null hypothesis was tested by *t*-test for all morphological characters. It is evident that for each character at least one combination has disproved

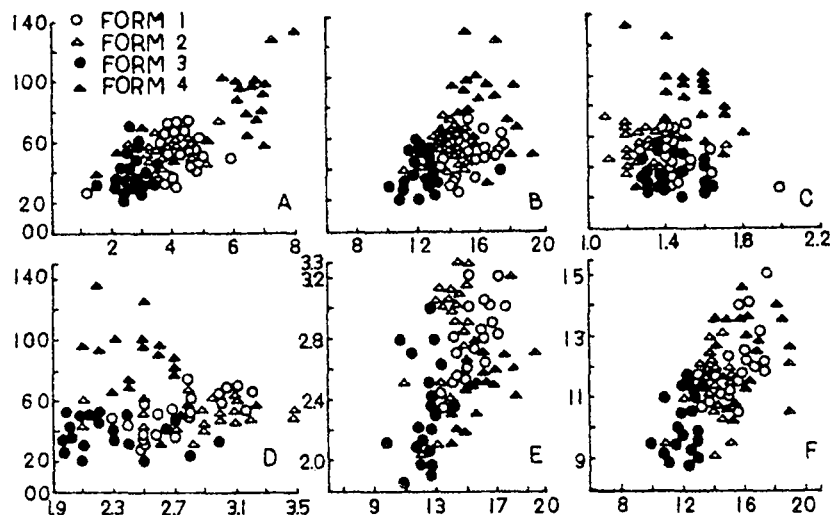


Figure 1. Anderson scatter diagram of the four *D. metel* forms. The sets of morphological characters (A-F) are given in §3.2 of the text.

Table 2. *t*-Values of 31 morphological characters in six sets of combinations among four forms of *D. metel*.

| Morphological characters | Forms | | | | | |
|-----------------------------------|---------|---------|---------|---------|---------|---------|
| | 1:2 | 2:3 | 3:4 | 1:3 | 2:4 | 1:4 |
| Length of largest lateral | 3.094* | 4.812* | 10.651* | 1.248 | 6.317* | 9.173* |
| Petiole length of 4th leaf | 0.903 | 6.011* | 8.054* | 6.207* | 4.829* | 4.094* |
| Area of 4th leaf | 0.739 | 4.133* | 7.152* | 3.415* | 4.724* | 4.948* |
| Length/Width ratio of 4th leaf | 3.539* | 2.989 | 2.465 | 1.134 | 4.850* | 1.305 |
| Petiole length | 7.121* | 1.575 | 12.061* | 1.351 | 3.718* | 11.975* |
| Calyx length | 4.885* | 1.022 | 5.300* | 1.705 | 8.843* | 5.801* |
| Calyx teeth number | 6.301* | 2.280 | 7.281* | 4.544* | 2.932 | 15.079* |
| Calyx teeth incision | 2.032 | 4.500* | 8.128* | 5.709* | 5.497* | 1.563 |
| Corolla length | 3.081* | 6.307* | 10.821* | 10.709* | 5.191* | 1.862 |
| Corolla length/Calyx length ratio | 1.094 | 4.500* | 2.113 | 4.232* | 3.254* | 2.695* |
| Corolla lobes | 2.990 | 2.990 | — | — | 2.990 | — |
| Acumen number | 2.919 | 2.919 | — | — | 2.979 | — |
| Acumen length | 19.175* | 15.189* | 20.650* | 4.580* | 6.322* | 22.931* |
| Corolla tube length | 3.949* | 6.601* | 9.072* | 10.459* | 4.720* | 1.548 |
| Depth of corolla lobing | 1.524 | 1.653 | 7.562 | 3.399* | 2.646* | 0.506 |
| Maximum diameter of corolla | 3.318* | 3.131* | 14.607* | 5.062* | 12.212* | 5.206* |
| Minimum diameter of throat | 1.123 | 4.941* | 16.405* | 2.494 | 9.953* | 8.803* |
| Stamen number | 6.750* | 6.750* | — | — | 6.750* | — |
| Stamen length | 7.839* | 1.130 | 6.811 | 9.222* | 4.895* | 2.044 |
| Stamenoid number | 6.974* | 6.974* | — | — | 6.974* | — |
| Anther length | 1.217 | 1.839 | 16.653* | 7.027* | 6.960* | 8.112* |
| Filament/anther ratio | 4.055* | 5.105* | 8.818* | 1.350 | 2.194 | 1.856 |
| Adnation of stamen to corolla | 2.383 | 3.101 | 17.333* | 6.451 | 14.083 | 12.836* |
| Pistil number | 5.253* | 5.253* | — | — | 5.253* | — |
| Pistil length | 2.461 | 3.816* | 0.085 | 6.299* | 3.040* | 0.670 |
| Capsule per plant | 2.478 | 2.875 | 1.434 | 0.493 | 4.474* | 2.083 |
| Capsule diameter | 3.837* | 5.502* | 2.839 | 3.671 | 4.722* | 1.465 |
| Spine length | 2.373 | 2.100 | 3.710* | 0.319 | 5.604* | 3.323* |
| Seed per capsule | 3.731* | 4.101* | 7.651* | 11.028* | 0.374 | 5.068* |
| Seed width | 0.831 | 0.987 | 1.414 | 2.084 | 0.000 | 1.042 |
| Seed length | 0.447 | 2.847 | 2.000 | 3.481* | 0.438 | 1.000 |

*Significant at 1 point level.

the null hypothesis of similarity. Out of the six sets five have disproved the hypothesis for two important characters *viz* seed length and seed width. Similarly, for the morphological character, depth of corolla lobing, three sets have disproved the null hypothesis.

3.4 Correlation matrix

Twenty seven morphological characters were worked out in the correlation matrix. There were 27 row characters against 27 column characters making it a 27 × 27 matrix.

giving 351 correlations coefficients. Many of these have become significant as form 1-132, form 2-85, form 3-77 and form 4-83.

The results indicate that quite a good number of morphological characters are specific to each form of *D. metel*. Two points emerged from the matrix (i) all the four forms are distinct entities and, (ii) since no environmental correlations could be established with the four forms of *D. metel*, they could be considered for separate taxonomic status.

4. Discussion

The mathematical approach undertaken as above ascertains the differences among the four forms. Anderson scatter diagram clearly marks the morphological variations. As shown in figure 1, various sets of characters were considered to prepare the scatter diagram. If the points are scattered over the plane of the graph, they evidently belong to different forms, if the points are assembled over a diagonal line they belong to the same population and the variation can be called as environmentally controlled and, if the groups of the points fall almost on the same line the different populations have possibly emerged from the same genetical stalk. It is clear in the present study that in all the four sets of characters the groups of points fall on a diagonal line indicating the possibility that though these forms exhibit higher degree of diversity in their morphological characters, they might have emerged from the same genetical stalk sometime in the remote past. Further, it is evident from the results that a large number of correlation coefficients are significant in each form. This implied that some of the morphological characters can be considered specific for each form. Similarly *t*-test was applied to see the relationships between the forms with respect to each of the 31 characters. On the basis of the total number of morphological characters which become significant between each of the two forms an inverted tree-like diagram has been prepared which gives a clear picture of the relationship among the four forms (figure 2). Thus it may be concluded that the forms which have emerged from a common genetical stalk in the past, have greatly diversified.

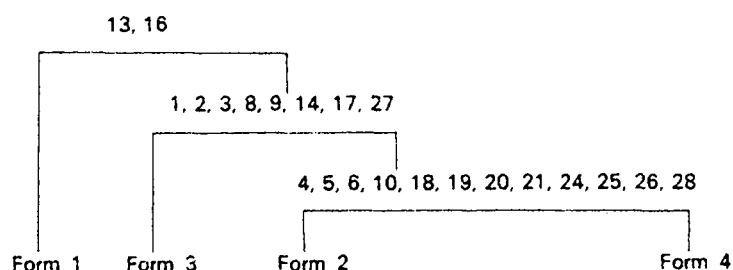


Figure 2. Degree of relationship among the four forms based on morphological characters. Numbers given are the morphological characters as cited in table 1.

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