Inheritance of some morphological characters in chickpea (Cicer arietinum L.)

V. L. Rathod*, V. N. Toprope, R. G. Tathe, A. R. Talape and S. S. Gavade

Department of Agricultural Botany, College of Agriculture, Latur, Maharashtra, India
*E-Mail: vrathod.no9@gmail.com

Abstract
The present investigation was undertaken to generate information on the inheritance of flower colour, leaflet size and pigmented stem in chickpea (Cicer arietinum L.). Parents, F₁’s, and F₂’s of crosses Vijay x PKV-4, Digvijay x PKV-4 and BDNG-797 x PKV-4 were evaluated during rabi, 2018-19. The monogenic inheritance was confirmed for two traits, pink vs. white flower colour and pigmented vs. non pigmented stem pigmentation. Leaflet size, small vs. broad was controlled by duplicate gene action. The genetic inheritance of these morphological traits is essential for the selection of superior and desirable transgressive segregants for the genetic improvement of the crop. These results are of essential significance because these traits are used as visual markers in chickpea breeding for early recognition of the hybrid nature of plants.

Key words: Chickpea, Inheritance, morphological traits.

In India, chickpea (Cicer arietinum L.) is cultivated at about 10.56 m. ha. area with a production of about 11.23 m.t. and productivity of 1063 kg/ha, which is lower than the global average. The low productivity could be ascribed to biotic and abiotic stresses, narrow genetic bases and poor management practices, etc. There are two distinct types of cultivated chickpea these are classified as desi and kabuli. Both types had been geographically isolated for many years are having great contrast for various plant architectural and yield component traits. Therefore, it may be possible to improve yield by transgressive hybridization. For that matter, it is essential to have knowledge about the mode of inheritance of the traits. Genetics of several morphological traits in chickpea has been reported by Rao et al. (1980), Tefera (1998), Sayyed (2000), Burse et al. (2017) and Gediya L.N. et al. (2018). The present study was, therefore, aimed to study the genetics of three morphological traits viz., flower colour, leaflet size and stem pigmentation in three crosses involving desi and kabuli parents.

The experimental material comprised of three crosses viz., Vijay x PKV-4, Digvijay x PKV-4 and BDNG-797 x PKV-4. The female parents were having pink flower colour, small leaflet size and pigmented stem and the male parent, PVK-4 were with white flower colour, broad leaflet and non pigmented stem (Table 1). The crosses were made during rabi, season 2017-18 to obtain the first filial (F₁) generation. Evaluation work was carried out with parents, F₁’s, and F₂’s which were grown during rabi 2018-19 at the Research Farm of Agricultural Botany Department, College of Agriculture, Latur in Randomized Block Design (RBD). Sowing was carried out at the spacing of 30 cm and 10 cm between the rows and plant, respectively. The dibbling method was used for sowing. At the time sowing recommended dose of fertilizer was 25 kg N + 50 kg P₂O₅ per hectare as well as other cultural practices were taken. During the period when the experiment was in the field, the weather condition remained suitable for the healthy growth of the crop. Observation took randomly selected plants in the F₁ generation and in F₂ on an individual
Inheritance of some morphological characters

Table 1. Characteristics of parents and their F₁'s

| S. No. | Name of parents and crosses | Flower colour | Leaflet shape | Stem pigmentation | Seed type |
|--------|----------------------------|--------------|--------------|-------------------|-----------|
| 1      | Vijay                      | Pink         | Small        | Pigmented         | Desi      |
| 2      | BDNG-797                   | Pink         | Small        | Pigmented         | Desi      |
| 3      | Digvijay                   | Pink         | Medium       | Pigmented         | Desi      |
| 4      | PKV-4                      | White        | Large        | Non Pigmented     | Kabuli    |
| 5      | Vijay × PKV-4              | Pink         | Medium       | Pigmented         | -         |
| 6      | Digvijay × PKV-4           | Pink         | Medium       | Pigmented         | -         |
| 7      | BDNG-797 × PKV-4           | Pink         | Medium       | Pigmented         | -         |

Plant basis. Flower colour was recorded at the time of flowering and it was recorded as white and pink colour. Leaflet size was observed on two leaves per plant on the fifth or sixth leaf from the top of primary branches for this measurement and sampling done at the time of 50% flowering. Stem pigmentation observation was made twice on single plants basis and recorded as pigmented or non pigmented (DUS test by PPV and FR Authority GOI, 2007). The chi-square test was applied to the observed segregation in the F₂ generations of the three crosses.

Flower colour is a useful morphological marker in chickpeas. The information on the inheritance of such morphological character would be helpful to the chickpea breeder in changing the architecture of the plant because flower colour is a valuable morphological marker in cultivated chickpea and also help in the early recognition of the hybrid character of plants (Hasan and Deb, 2013).

In the present investigation, inheritance of flower colour was studied in three crosses viz., Vijay x PKV-4, Digvijay x PKV-4 and BDNG 797 x PKV-4. The female parents, Vijay, Digvijay and BDNG 797 were pink flowered and male parent PKV-4 was white flowered (Table 2 & Plate 1). All three crosses between pink flowered and white flowered parents gave pink flowered F₁. A good fit to a 3: 1 ratio for pink and white flowered plants was observed in the F₂ of all crosses with non significant χ² values. The ratio was confirmed by non significant value of the analysis of the heterogeneity among the crosses (χ²_Heterogeneity = 0.249 at df = 2; p = 0.882), suggesting that the white colour is recessive over pink colour and inherited mono-genically. It was noted that, in chickpea, single gene inheritance has been reported between pink and white flower colour parents by several researchers such as Pimplikar (1943), Patil (1967), Mian (1971), Sayyed (2000), Jain (2003), Atanasov and Mihov (2006), Hasan and Deb (2013) and Burse et al. (2017).

Inheritance of leaflet size was studied in three crosses viz., Vijay x PKV-4, Digvijay x PKV-4 and BDNG-797 x PKV-4. For this purpose, Vijay, Digvijay and BDNG-797 (small leaflets) were crossed with PKV-4 (broad leaflets) (Plate 1). In the F₁ generation, all crosses had small

Table 2. Segregation for flower colour in F₂ generation of three crosses of chickpea

| S. No. | Name of the crosses/ Parents/ generations | Flower color | Expected ratio | Number of plants | χ² | P value |
|--------|------------------------------------------|--------------|----------------|------------------|----|--------|
|        |                                          | F₁           | F₂             | Observed         | Expected |
| 1      | Vijay (Pink) x PKV-4 (White)             | Pink         | Pink           | 109              | 100.5 | 2.875   | 0.089  |
|        |                                          | F₁           | White          | 25               | 33.5  |         |        |
| 2      | Digvijay (Pink) x PKV-4(White)           | Pink         | Pink           | 75               | 70.5  | 1.148   | 0.283  |
|        |                                          | F₁           | White          | 19               | 23.5  |         |        |
| 3      | BDN 797 (Pink) x PKV-4 (White)           | Pink         | Pink           | 115              | 109.5 | 1.105   | 0.293  |
|        |                                          | F₁           | White          | 31               | 36.5  |         |        |
|        | Heterogeneity(df-2)                      |              |                |                  | 0.249 | 0.882   |        |

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Plate 1. Variation in morphological characters of chickpea

FLOWER COLOR

Pink flower (*Desi*)

White flower (*Kabuli - PKV 4*)

LEAFLET SIZE

Broad leaflet (*Kabuli - PKV4*)

Small leaflet (*Desi*)

STEM PIGMENTATION

PIGMENTED (*Desi*)

NON PIGMENTED (*Kabuli*)
leaflets since small leaflets size was dominant over broad leaflets size. In the $F_2$ generation, all three crosses and pooled data gave a good fit to 15:1 (small: broad) leaflet size (Table 3). The ratio was confirmed by non significant value of the analysis of the heterogeneity among the crosses ($X^2_{Heterogeneity} = 2.111$ at df = 2; $p = 0.347$), suggesting that broad leaflet is recessive and controlled by duplicate gene action. Digenic inheritance of leaflet size was also reported by earlier workers like Pandey and Tiwari (1981).

The inheritance of stem pigmentation was studied in three crosses viz. Vijay x PKV-4, Digvijay x PKV-4 and BDNG-797 x PKV-4. The female parents viz., Vijay, Digvijay and BDNG-797 (Pigmented) were crossed with the male parent, PKV-4 (Non pigmented). In these crosses and their pooled data gave a good fit to 3 pigmented: 1 non pigmented, suggesting that the non-pigmented trait character was recessive over pigmented and controlled monogenically (Table 4 and Plate 1). This is confirmed by non significant heterogeneity test ($X^2_{Heterogeneity} = 3.650$ at df = 2; $p = 0.161$), and which agree with the earlier findings of Ghatge (1994), Tefera (1998) and Sayyed (2000).

This experiment also reported that white flower and non pigmented stem was highly heritable in the $F_2$ generation and these traits could be manipulated easily into other variety to make new recombination with desi chickpea because it is admitted that the white flower colour and

**Table 3. Segregation for leaflet size in $F_2$ generation of three crosses of chickpea**

| S. No. | Name of the crosses      | Parents/ generations | Leaflet size | Expected ratio | Number of Plants | $\chi^2$ | $P$ value |
|--------|--------------------------|----------------------|--------------|----------------|-----------------|---------|----------|
|        |                          |                      |              | Observed       | Expected        |         |          |
| 1      | Vijay (Small) x PKV-4 (Broad) | $F_1$                | Small        | 15             | 122             | 125.6   | 1.673    | 0.195    |
|        |                          | $F_2$                | Small        | 1              | 12              | 8.4     | 1.163    | 0.283    |
|        |                          |                      | Broad        | 1              | 12              | 8.4     | 2.111    | 0.150    |
| 2      | Digvijay (Small) x PKV-4 (Broad) | $F_1$                | Small        | 15             | 84              | 88.1    | 0.043    | 0.838    |
|        |                          | $F_2$                | Small        | 1              | 10              | 5.9     | 0.380    | 0.539    |
|        |                          |                      | Broad        | 1              | 9               | 9.1     | 0.001    | 0.965    |
| 3      | BDN 797 (Small) x PKV-4 (Broad) | $F_1$                | Small        | 15             | 137             | 136.9   | 0.001    | 0.965    |
|        |                          | $F_2$                | Small        | 1              | 9               | 9.1     | 0.001    | 0.965    |
|        |                          |                      | Broad        | 1              | 34              | 36.5    | 0.542    | 0.459    |

**Table 4. Segregation for stem pigmentation in $F_2$ generation of three crosses of chickpea**

| S. No. | Name of the crosses      | Parents/ generations | Stem pigmentation | Expected ratio | Number of plants | $\chi^2$ | $P$ value |
|--------|--------------------------|----------------------|-------------------|----------------|-----------------|---------|----------|
|        |                          |                      |                   | Observed       | Expected        |         |          |
| 1      | Vijay (Pigmented) x PKV-4 (Non Pigmented) | $F_1$                | Pigmented         | 3              | 109             | 100.5   | 2.875    | 0.089    |
|        |                          | $F_2$                | Pigmented         | 1              | 25              | 33.5    | 0.001    | 0.965    |
|        |                          |                      | Non Pigmented     | 1              | 25              | 33.5    | 2.875    | 0.089    |
| 2      | Digvijay (Pigmented) x PKV-4 (Non Pigmented) | $F_1$                | Pigmented         | 3              | 66              | 70.5    | 0.148    | 0.283    |
|        |                          | $F_2$                | Pigmented         | 1              | 28              | 23.5    | 1.148    | 0.283    |
|        |                          |                      | Non Pigmented     | 1              | 28              | 23.5    | 1.148    | 0.283    |
| 3      | BDN 797 (Pigmented) x PKV-4 (Non Pigmented) | $F_1$                | Pigmented         | 3              | 112             | 109.5   | 0.001    | 0.965    |
|        |                          | $F_2$                | Pigmented         | 1              | 34              | 36.5    | 0.028    | 0.632    |
|        |                          |                      | Non Pigmented     | 1              | 34              | 36.5    | 0.028    | 0.632    |

Heterogeneity(df-2)

2.111 0.347

3.650 0.161
non pigmented stem are the main identities of kabuli chickpea. Therefore, the study of flower colour and stem pigmentation revealed that the inheritance pattern of qualitative traits of chickpea is monogenic in nature and simply inherited mendelian’s ratio.

The results of the present experiment on the inheritance of morphological characters would be helpful to the chickpea breeder to use in changing the architecture of the chickpea, early recognition of the hybrid character of plants and can be used as a valuable morphological marker in cultivated chickpea.

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