

Segregation of Flower and Pod Colour Inheritance in F₂ and F₃ Generations of Cowpea (*Vigna unguiculata* (L.) Walp.)

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Abstract — Cowpea (*Vigna unguiculata* L. Walp) is a multi-purpose, underutilized legume crop mostly grown in dry tropical areas. It is one of the maximum crucial food legume vegetation, famous large morphological variability in its wild as well as cultivated bureaucracy. The present investigation was carried out in F₁, F₂ and F₃ generations of four inter sub-specific crosses (RC101×Vyjayanthi, RC101× Vellayani jyothica, ACM 05-02×Ettumanoor local and ACM 05-07× Vyjayanthi) of cowpea to study the inheritance pattern of flower pod colour in F₂ and F₃ generations. Inheritance of flower colour and pod colour in cowpea has followed a qualitative pattern. Purple flower colour is dominant over white colour flower whereas, purple colour pod is partially dominant over green pod colour. A segregation ratio of three purple: 1 white flower coloration in F₂ technology of two crosses indicated that white flower color is managed by single recessive. Whereas segregation ratio of F₂ 1 green; 2 Light purple: 1 purple colour pod indicated that purple colour pod is partially dominant over green pod colour and it's governed by single gene.

Keywords — Cowpea; Cultivated Forms; Inheritance of Flower Colour.

1. Introduction

Cowpea [*Vigna unguiculata* (L.) Walp.], Fabaceae (2n = 2x = 22)] is an important dual purpose (food and forage) legume crop widely grown under low input production systems and in arid and semi-arid agro-ecologies of the world. It is eaten as a grain pulse, green pod and green seeds (Belay and Fisseha, 2021). Cowpea can be grown quite successfully under conditions that are totally unsuitable for the common bean Pandiyan et al. (2020). It is cultivated on about 14.5 million hectares on the world's arable land, with an annual grain production of 6.2 million metric tons, and out of this, Africa accounts for 83.4 % (Kebede and Bekeko, 2020; Owusu et al. 2021).

As a legume, it is also a vital thing of conventional cropping structures considering rhizobium facilitation fixes atmospheric nitrogen and contributes to soil fertility improvement, particularly in smallholder farming structures in which very little fertilizer is used. Cowpea suits well in a ramification of cropping systems and is grown as cover crop, blended crop, seize crop and green manure crop. Cowpea also serves as a really perfect crop for soil and water conservation due to its capability to grow fast and cover the soil floor speedy (Eswaran et al. 2007). Although cowpea is understood to be drought tolerant while in comparison to other vegetation, the productiveness of cowpea types is hampered by means of erratic rainfall, and plenty of are practical to high temperatures.

However grain yield of this legume varies widely when grown at distinctive area. Cowpea is considerably grown in

India especially within the states of Rajasthan, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu. The productiveness potential of cowpea in Tamil Nadu is low 265 kg/ha compared to the countrywide productivity. This clearly indicates the need to pick out the reason for this type of low productivity in India and in particular in Tamil Nadu.

Three distinct botanical varieties of the cultivated cowpea are recognised (Faris, 1965). *V. unguiculata* var. *unguiculata*, the catjang cowpea is the primitive of all the varieties and predominance in Africa. The pods are 80 – 130 cm long and erect. *V. unguiculata* var. *sinensis*, the common cowpea has most of its form in Africa where the crop is more highly specialised.

The pods are 200 – 300 m in length. *V. unguiculata* var. *sesquipedalis*, the yard lengthy bean or asparagus bean is maximum broadly grown in the ways east, typically for its immature pods. The pod is 30 – 100 cm long. However, there is little justification in upgrading them to the specific rank since the three can be crossed freely and free gene flow is possible.

Pods have different colours but consumer's preference is for green pod colour for vegetable purpose. The principle flower colours in Cowpea are dark, pale, tinged or white. Flower colour and pod colour being less influenced by environmental variations are used as markers in the identification of species or varieties. Pigmentation is a common feature of cowpea and its presence is due to the anthocyanin pigment. This soluble compound imparts purple colour on the shoot, pods and petals of cowpea. Limited works have been carried out on the inheritance of

flower colour and pod colour in cowpea, therefore, the present investigation was carried out.

2. Materials and Methods

Two true breeding genetically diverse lines of cowpea namely, ACM 05-02 (cream colour flower and green colour pod with purple tip) and ACM 05-07 (light purple colour flower and green colour pod) were developed from Agricultural College and Research Institute, Madurai, one national variety RC 101 (white colour flower and green colour pod) developed from Central Arid Zone Research Institute, Jodhpur and three local varieties namely, Vyjayanthi (purple colour flower and purple colour seed), Vellayani jyothica (pale yellow colour flower and green pod) and Ettumanoor local (cream with purple flower and green pod) were collected from Kerala were chosen for this study.

Advanced lines and national variety were characterized by dwarf, early flowering with short pod and grain (*V. unguiculata subspecies sinensis*) types and local varieties were characterized by climber, late flowering with long pod and vegetable (*V. unguiculata subspecies sesquipedalis*). An investigation was carried out in F₁, F₂ and F₃ generations of four inter sub-specific crosses (RC101×Vyjayanthi, RC101×Vellayani jyothica, ACM 05-02×Ettumanoor local and ACM 05-07×Vyjayanthi) of cowpea. In these crosses RC 101, ACM 05-02 and ACM 05-07 were grain type parents and Vyjayanthi, Vellayani jyothica and Ettumanoor local were vegetable parents which are having long purple pods in the climbers.

The cross combinations were effected, the hybrids F₁, F₂ and F₃ progenies were evaluated along with their parents. Four crosses for the study of flower colour and pod colour comprising F₁, F₂ and F₃ generations were developed. The materials were grown in Randomized Block Design with three replications during main rainy season at Agricultural College and Research Institute, Madurai with row to row spacing of 90 cm and plant to plant spacing of 20 cm. There were single row of the non-segregating generations (P₁, P₂ & F₁) and eight rows of F₂ and F₃ generations. Flower colour and pod colour of the individual plants were recorded from the all the five generations of the four crosses Chi-square test was applied to test goodness of the fit for observed segregation ratios.

Table 1. Details of the parents involved in the four cross combinations

S. No	Parents	Source of origin
<i>Vigna unguiculata subspecies. sinensis</i>		
1	RC101	Central Arid Zone Research Institute, Jodhpur
2	ACM 05 02	Agricultural College and Research Institute, Madurai.
3	ACM 05 07	Agricultural College and Research Institute, Madurai.
<i>Vigna unguiculata subspecies. sesquipedalis</i>		
4	Vyjayanthi	Kerala Agricultural University, Thrissur, Kerala.
5	Vellayani jyothica	Kerala Agricultural University, Vellayani, Kerala.
6	Ettumanoor local	Kerala Agricultural University, Vellayani, Kerala.

3. Results and Discussion

3.1 Flower Colour

The F₁ s viz., cross 1 (RC101 × Vyjayanthi) and cross 4 (ACM 05 07 × Vyjayanthi) had purple colour flower which indicated that purple colour flower is a dominant trait. The dominant nature of purple colour over white colour was confirmed by F₂ generations. There are two distinct classes i.e., purple and white in the F₂ and F₃ generations (Table 2). The pattern of segregation in F₂ gave a good fit to 3 purple: 1 white flower colour (Table 1). This indicated that a single recessive gene pair conditioned white flower colour in RC 101 and ACM 05-07. This further confirmed the monogenic recessive nature of white colour flower in cowpea. Jindla and Singh (1970) and Hanchinal and Goud (1978) reported dominant nature of violet flower colour over very light violet colour, whereas Uguru (1995) observed partial dominance of purple petal colour over white petal colour in a cross of white and purple petal coloured parents.

Harland (1919) and Spillman and Sando (1930) suggested that the R factor is essential for expression of flower colour and rr for white flower colour. Based on the above studies, the gene symbols R and rr are assigned for purple and white flower, respectively.

Table 2. Mode of segregation for flower colour in Cowpea

Cross	Generation	No. of plants			Ratio	Chi square Value	P value
		Purple	White	Total			
RC101×Vyjayanthi	F ₂	206	63	269	3:1	0.357	0.70-0.50
ACM 05-07×Vyjayanthi	F ₂	199	72	271	3:1	0.356	0.70-0.50

4. Pod Colour

The F₁ s viz., cross 1 (RC101 × Vyjayanthi) and cross 4 (ACM 05 07 × Vyjayanthi) had light purple colour pod. This indicated that purple colour pod is partial dominant over green colour pod. F₂ segregation gave a good fit to the expected ratio of 1 green: 2 light purple: 1 purple in both the crosses (Table 2). Singh 2002, noted the

monogenic dominance of brownish straw shade of pods over straw colored pods. Premsekar and Raman (1972) located that mild inexperienced pods and are conditioned by using a unmarried gene in cowpea. However, Hanchinal and Goud (1978) reported that two genes are responsible for expression of green pod colour, whereas, Uguru (1995) observed that purple colour of pods is governed by two genes in cowpea.

Table 3. Mode of segregation for pod colour in Cowpea

Cross	Generation	No. of plants				Ratio	Chi square Value	P value
		Green	Light purple	Purple	Total			
RC101×Vyjayanthi	F ₂	69	135	63	267	1:2:1	0.303	0.70-0.50
ACM 05-07× Vyjayanthi	F ₂	52	105	49	206	1:2:1	0.165	0.70-0.50

5. Segregating Pattern in F₃ Generations

Morphological characteristic of parents and their crosses in F₃ generation details were given in table 4 and fig. 1. Cross RC101 x Vyjayanthi RC101 had Dwarf, early flowering plant type, white coloured flowered, Short, green colour pods and dull white colour and round, small sized seeds and Vyjayanthi had Climber, late flowering plant type, purple coloured flower, long and purple colour pods and purple oval, long sized seeds. Its F₃ progenies had Dwarf late, dwarf early, medium early, medium late, tall early and tall late plant type; White, white purple shade, light purple and purple coloured flowers, Short green, short purple, medium green, medium purple, long green and long purple type pods and white colour and oval small, white colour and oval medium, white colour and oval long, black colour and round small, black colour and round medium, black colour and oval long and purple with white colour and oval long seeds besides their parental type, colour, size and shape.

In cross RC101 × Vellayani Jyothica, involving the parents RC 101 nature has Dwarf, early flowering plant type, white coloured flowered, Short, green colour pods and dull white colour and round, small sized seeds and Vellayani Jyothica had Climber, late flowering plant type, Pale yellow coloured flowers, Long, Purple type pods and Purple with white mottled and oval long sized seeds and their F₃ progenies had Short early, short late, tall early and tall late type plants, White, pale yellow with purple shade, pale yellow coloured flowers, Short green, medium green and long green type pods and White oval small, white oval

medium, white mottled black, white mottled black oval small, white mottled black oval medium and brown oval medium size seeds.

The cross ACM 05 02 × Ettumanoor local F₃ progenies had Medium early and short early type plants, Cream, cream with light purple shade and cream with dark purple shade coloured flowers, Medium green with purple tip and long green with purple tip type pods and Black mottled cream oval small, black mottled cream oval medium, black mottled cream oval long, brown oval medium and brown mottled cream oval medium sized seeds. But these both parents are different from their segregants like ACM 05 02 had Medium, early flowering plant type, Cream coloured flowers, Short and green with purple tip type pods and Pure white and round, medium sized seeds and Ettumanoor local had Climber, late flowering type plants, Cream with purple coloured flowers, Long, green pods and Dark purple and long, bold sized seeds. While in cross ACM 05 07 x Vyjayanthi ACM 05 07 had Medium, early flowering type plants, Light purple coloured flowers, Medium, green type pods and cream coloured round, small sized seeds and Vyjayanthi had Climber, late flowering type plants, purple coloured flower, long and purple colour pods and purple and oval, long sized seeds. Its F₃ progenies had cream color and oval medium, cream colour and oval long, brown colour and oval small, brown colour and oval medium, shiny dark black colour and oval medium, dark black colour and oval medium, dark black colour and round medium and purple colour and oval medium besides their parental size and shape.

Table 4. Morphological characteristic of parents and their crosses in F₃ generation

Genotypes/ Crosses	Plant type	Flower colour (Standard petal)	Pod colour	Seed colour and size
RC 101	Dwarf, early flowering	White	Short, green	Dull white and round, small

ACM 05 02	Medium, early flowering	Cream	Short and green with purple tip	Pure white and round, medium
ACM 05 07	Medium, early flowering	Light purple	Medium, green	Cream and round, small
Vyjayanthi	Climber, late flowering	purple	Long, Purple	Purple and oval, long
Vellayani Jyothica	Climber, late flowering	Pale yellow	Long, green	Purple with white mottled and oval long
Ettumanoor local	Climber, late flowering	Cream with purple	Long, green	Dark purple and long,bold
Cross 1 (RC101 × Vyjayanthi)	Dwarf late, dwarf early, medium early, medium late, tall early and tall late,	White, and purple	Short green, short purple, medium green, medium purple, long green and long purple	White oval medium, white oval long, black round small, black round medium, black oval long and purple with white oval long
Cross 2 (RC101 × Vellayani Jyothica)	Short early, short late, tall early and tall late	White, pale yellow with purple shade, pale yellow	Short green, medium green and long green	White oval small, white oval medium, white mottled black, white mottled black oval small, white mottled black oval medium and brown oval medium
Cross 3 (ACM 05 02 × Ettumanoor local)	Medium early and short early	Cream, cream with light purple shade and cream with dark purple shade.	Medium green with purple tip and long green with purple tip	Black mottled cream oval small, black mottled cream oval medium, black mottled cream oval long, brown oval medium and brown mottled cream oval medium
Cross 4 (ACM 05 07 × Vyjayanthi)	Medium early, medium late, tall early, tall late	white and purple	Small purple, medium purple, long purple, small green, medium green and long green	Cream oval medium, cream oval long, brown oval small, brown oval medium, dark black oval medium, dark black oval medium, dark black round medium and purple oval medium.

6. Independent Assortment

In F₂ generation of Cross RC101 × Vyjayanthi and Cross ACM 05 07 × Vyjayanthi , each of purple as well as white coloured flowers produced pods of all the three coloured pods viz., purple, light purple and green coloured pods. F₂ phenotypic ratio gave a good fit to 3 purple flower and purple pods; 6 purple flower and light purple pods; 3 purple flower and green pods; 1 white flower and purple pod; 2 white flower and light purple pod; 1 white flower and green pod which confirmed that flower colour and as well as pod colour are controlled by single gene and situated on separate chromosome.

7. Conclusion

Some of the F₃ segregants in all the crosses had besides their parental type, colour, size and shapes. It will be much useful for the plant breeders to develop different coloured and various sized new cowpea genotypes in future breeding programmes.

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