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INHERITANCE PATTERN OF SEED COAT TEXTURE IN COWPEA (*VIGNA UNGUICULATA* (L.) WALP.

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ABSTRACT

Seed coat texture in cowpea has been reported to be heritable but with conflicting mode of inheritance. Hence, understanding the mode of inheritance for this trait is important to developing acceptable cowpea varieties for Nigeria's consumers. The objectives of this study were to determine the mode of inheritance of seed coat texture and determine the pattern of dominance of seed coat texture in cowpea. Four generations of cowpea, P_1, P_2, F_1, and F_2 were derived from each of two bi-parental crosses of TVu 4669 x Vita 7 and Ife Brown x TVu 2723, each pair of parents having contrasting characteristics for seed coat textures (i.e. rough and smooth). Different generations were evaluated in an experiment laid out in a randomized complete block design with three replicates for the parents, (P_1 and P_2), F_1 population and four replicates for the F_2 population at the spacing of 60cm x 30cm. Data on seed coat texture collected from the crosses by visual observation were subjected to Test of Goodness-of-Fit. The F_2 plants for the two different crosses yielded 72 smooth seed coat and 23 rough seed coat texture and 66 smooth and 20 rough seed coat textures respectively closely fitted a 3 smooth: 1 rough ratio. Statistically, chi-square - $\chi^2 = 0.032$ at ($P<0.05$) confirmed there was no significant difference between the observed and expected values as the calculated. This indicates that seed coat texture is controlled by a pair of single genes and under a monogenic inheritance. Smooth seed coat texture was also observed to be dominant over rough seed coat texture in all the crosses.

Key words: cowpea, Mendelian ratio, seed coat texture, segregation.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L.) Walp is an important grain legume crop in the tropical and subtropical regions of the world. It is of major importance to the livelihood of millions of relatively poor people in comparatively less developed countries of the tropics. In Nigeria, cowpea is the most important source of plant protein with a high protein content of about 22% and it also provides a cheap source of dietary protein for low-income in urban and rural populations. In addition to their use as a protein-rich food crop, cowpeas are extensively grown as a hay crop and as a green manure or cover crop. Cowpea contributes 60 – 70 KgN/ha in the soil due to its nitrogen fixing properties and also serves as a residue, which benefits the succeeding crops. It is also shade tolerant and, therefore, compatible as an intercrop with a number of cereals and root crops, as well as with cotton, sugarcane and several plantation crops. Coupled with these attributes, its quick growth and rapid ground cover have made cowpea an essential component of sustainable subsistence agriculture in marginal lands and drier regions of the tropics, where rainfall is scanty and soils are sandy with little organic matter (Singh *et al*., 1997).

There are some biotic factors that affect the production of cowpea; such as pests and diseases. Pests like Aphids (*Aphis craccivora*) affects cowpea before anthesis, Flower bud thrips (*Megalurothrips sjostedti*) affects cowpea during anthesis, Maruca pod borer (*Maruca vitrata*) affects cowpea during podding, and Bean weevils are storage pests of cowpea. These pests are a major factor in the low yields of African cowpea crops which is responsible for over 70% loss in yield (Oladejo *et al.*, 2017). Apart from its low yield and productivity, a major problem of cowpea is prolonged cooking of many cowpea varieties and this makes cooking to be inconvenient and cost ineffective - high cost of fuel and loss of nutritional values (Burr *et al*., 1968; Myaka and Lwaitama, 1993). The long cooking time required to prepare dishes compared to other foods stuff is not encouraging; coupled with the fact that the use of open wood fires in African homes is a gross disadvantage to environmental sustainability because it enhances deforestation and air pollution in carbon burning that results in the accumulation of carbondioxide in the atmosphere.

Seed coat texture is a major determinant for consumer’s acceptability of cowpea. The rough-seeded cowpea is preferred in Nigeria and other West African countries because of the ease of dehulling, swelling capacity which are used for processed food such as *akara* and *moimoin* and also the short cooking time of cowpea seeds.

The mode of inheritance of seed coat texture has been controversial in literatures. Kehinde and Ayo-Vanghan (1999) reported that the trait is controlled by two genes with complementary effect while Rajendra *et al.* (1979) and Yilwa (2001) reported that the trait is controlled by a gene. Hence, studying the mode of genetic control for this trait is important to know the number of effective factors that controls it. The objectives of the research were to determine the mode of inheritance of seed coat texture in some varieties of cowpea and identify the pattern of dominance of seed coat texture in cowpea.

MATERIALS AND METHODS

The genetic materials used in the study includes four varieties of cowpea which are TVu 4669, TVu 2723, Ife Brown, Vita 7. These varieties were obtained from the Department of Crop Production and Protection, Obafemi Awolowo University, Ile-Ife and International Institute of Tropical Agriculture, IITA Ibadan both in Nigeria. The seed coat types of these lines are presented in Table 1 based on International Board on Plant Genetic Resources Descriptor (IBPGRD) and newly known as Bioversity International.

TABLE 1. NAMES AND SEED COAT TYPES OF PARENTAL LINES USED IN THE STUDY

Variety	Seed coat texture
TVu 4669	Rough
TVu 2723	Smooth
Ife Brown	Rough
Vita 7	Smooth

The different types of crosses made among cowpea varieties having different seed coat textures were as follows:

i. TVu 4669 (rough) x Vita 7 (smooth)
ii. Ife Brown (rough) x TVu 2723 (smooth)

The crosses were carried out at the Faculty of Agriculture Greenhouse, and the evaluation of generations was done at the experimental plot, Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife, Nigeria. The experiment was laid out in randomized complete block design with three replicates for evaluation of parents (P_1 and P_2) and F_1 population and four replicates for the F_2 population at spacing of 60cm x 30cm. Parents and F_1 are non-segregating generations while F_2 plants are segregating hence, the need to have more of F_2 planted for ease and greater possibility of expressing transgressive segregation. NPK 15:15:15 fertilizer was applied to boost the performance of the plants. Due to aphids (*Aphis craccivora*) attack, Cypermethrin at 10% E.C was applied at the rate of 10 ml per liter of water. The seeds were harvested at maturity, dried, threshed and visual observation was used to count and classify seed coat texture into smooth and rough.

Genetic and statistical analyses

Data for the inheritance of seed coat texture were subjected to Chi-square analysis to test for the goodness of fit to the proposed segregation ratio using Statistical Programme for Social Science (SPSS) 16.0 version.

$$\chi 2 = \left[\sum (O - E)^2 / E\right]$$

Where: χ^2= chi-square, O= observed values E= expected values

The purpose of the test is to evaluate how likely the observations that are made would be, assuming the null hypothesis is true. The tested hypothesis for this study are the null and alternative hypothesis which are as follows:

H_o: Seed coat texture trait is controlled by a pair of single genes or it is a monogenic trait.
H_a: Seed coat texture is not controlled by a pair of single genes or it is not a monogenic trait.

RESULTS AND DISCUSSION

Results of the two crosses analyzed to study seed coat texture are presented in Table 2 and 3. Crosses involving TVu 4669 (rough) and Vita 7 (smooth) showed that the parental lines bred true (i.e., there was no evidence of segregation in the seeds produced by each of the parental lines). All F_1 plants derived from the cross had rough seed coat texture. The F_2 plants yielded 72 smooth seed coat and 23 rough seed coat texture (which closely fits a 3 smooth: 1 rough Mendelian ratio) due to segregation. This result confirms the dominance of smooth seed coat texture over rough seed coat texture. Statistically, there is no significant difference between the observed and expected values as depicted in Table 2. The calculated chi-square - χ^2 value (0.032) was less than the tabulated value (3.84) at ($P<0.05$). The null hypothesis is hence accepted, and the seed coat texture is declared to be controlled by a pair of single genes or it is a monogenically inherited trait.

TABLE 2. SEGREGATION PATTERN OF SEED COAT TEXTURE IN TVU 4669 (ROUGH) X VITA 7 (SMOOTH) CROSS.

Generation	Observed number of plants: smooth	rough	Total	Expected ratio	χ^2
TVu 4669 (P_1)	0	12	12		
Vita 7 (P_2)	12	0	12		
F_1	0	14	14		
F_2	72	23	95	3:1	0.032

Not significant at 0.05 level of probability

i. F_1 = first filial generation

ii. F_2 = second filial generation

Degree of freedom= 1

Critical Chi-square tabulated=3.84 at 0.05 level of probability.

Results from the cross involving Ife Brown (rough) and TVu 2723 (smooth) also showed that the parental line bred true (there was no evidence of segregation in the seeds produced by each of the parental lines Ife Brown and TVu 2723, respectively). The F_1 of the cross produced solely smooth coat texture seeds while the F_2 plants produced 66 smooth and 20 rough seed coat textures (which closely fits a 3 smooth: 1 rough ratio). This suggests the monogenic nature of the inheritance of the trait and more so, there was no significant difference between the observed and expected values as depicted (Table 3), and the calculated chi-square value (0.140) is less than the tabulated value (3.84). The null hypothesis is therefore accepted, and the seed coat texture is declared to be controlled by a pair of single genes or it is a monogenic trait. This observed ratio also validated the dominance of smooth seed coat texture over rough seed coat texture as earlier reported (Yilwa, 2001). Several findings on the inheritance of morphological characters and some yield related traits in cowpea have been reported in the literatures. Singh and Ishiyaku (2000) reported that two pairs of independent recessive genes confer inheritance of rough seed coat texture in cowpea; and the presence of at least one dominant gene at each of the two loci results into smooth seed coat. They also reported that the recessive gene pair for rough seed coat in white-seeded varieties, Kanannado and IAR 1696, is different from the one in brown-seeded varieties IT89KD-941-1 and IT93K-693-2. The foregoing observation is giving an insight that mode of inheritance seed coat texture is colour specific; but the interaction of seed coat colour and mode of inheritance is not the main focus of this study; this can be investigated in subsequent studies. It is also noteworthy that prior to the present study some scientists have suggested a recessive gene pair control the inheritance of rough seed coat texture in cowpea (Rajendra *et al*. (1979; Singh and Ishiyaku, 2000). In the same vein, Ojomo, (1977) reported monogenic segregation pattern for hastate leaf shape;

flower colour (Hanchimal and Goud, 1978) and dehiscent pod (Aliboh, *et al*., 1995). In the present study, it could be detected that seed coat texture is controlled by two number of effective factors (a pair of genes) and there is dominance of smooth seed coat over the rough as corroborated various scientists (Singh and Ishiyaku, 2000; Yilwa, 2001; Drabo, 1981). More precisely, Rajendra *et al*. (1979) had previously studied cowpea seed coat texture and observed two anatomically different macroscleroid arrangements; the perpendicular arrangement to the cotyledon was correlated with smooth seed coat texture and the parallel arrangement to the cotyledon was correlated with rough seed coat texture. They further observed that the perpendicular arrangement was dominant over the parallel arrangement, and this was controlled by a single dominant gene, PC. This result suggested seed coat texture is of monogenic inheritance unlike most morphological and phenological traits in cowpea which are polygenic, quantitative or continuous characters and their expressions are mainly influenced by environmental conditions (Oladejo *et al*., 2019; Egbadzor *et al*. 2014). Having exhaustively discussed the results of this study, it is now convincing to categorically arrive at the logical inference.

TABLE 3: SEGREGATION PATTERN FOR SEED COAT TEXTURE IN IFE BROWN (ROUGH) X TVU 2723 (SMOOTH) CROSS.

	Observed number of plants				
Generation	smooth	rough	Total	Expected ratio	χ^2
Ife Brown (P_1)	0	12	12		
TVu 2723 (P_2)	12	0	12		
F_1	16	0	16		
F_2	66	20	86	3:1	0.140

Not significant at 0.05 level of probability
F_1 = first filial generation
F_2 = second filial generation
Degree of freedom=1
Critical chi-square tabulated= 3.84 at 0.05 level of probability.

CONCLUSION

It could be concluded from this study that seed coat texture in cowpea is controlled by a pair of single genes. The study also revealed that smooth seed coat texture is completely dominant over rough seed coat texture in cowpea as revealed in crosses: TVu 4669 (rough) x Vita 7 (smooth) and Ife Brown (rough) x TVu 2723 (smooth). This information is very useful to cowpea breeders and suggests that significant improvement can be made in cowpea breeding programmes by developing acceptable rough seed coat textures of cowpea varieties through hybridization which is the consumers' preference in the market.

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