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Original Research Article

Determination of Gene Action in Six Agronomic Characters of Selected Castor Accessions in a 5×5 Diallel Crosses

Manga Ayuba Gila[1] and Josiah Chukwudi Onovo[2]*

[1]Department of Biology, College of Education, Akwanga, Nasarawa State, Nigeria
[2]Department of Biological Sciences, Nasarawa State University, Keffi, Nigeria

**Corresponding author.*

Abstract

Five accessions selected from a germplasm of castor accessions assembled for character evaluation in the University of Agriculture Makurdi Teaching and Research Farm were crossed in all possible combinations excluding reciprocals. An evaluation trial experiment was laid out at Akwanga and Lafia in Nasarawa State, and Makurdi in Benue State. The parents and the F_1s were evaluated in a randomized complete block design of three replications. The plots were made up of three rows of 1.5 m in length and spaced 1.0 m apart. The rows were sown to four hills of two seeds each, spaced 0.5 m and thinned to single stand per hill. The consistency t^2 test values for all the characters were non-significant. The regression coefficient b in number of leaf lobes, number of nodes to primary panicle, height to primary panicle and plant height has fulfilled the additive-dominance model. On the other hand, b in leaf area and leaf length has failed to fulfill the additive-dominance model, hence has implicated epistatic gene action. The leaf characters; leaf area, leaf length and number of leaf lobes are conditioned by over-dominance gene action, while number of nodes to primary panicle, height to primary panicle and plant height are conditioned by partial gene action. Few of the non-additive genes exerted profound effect over the many additive genes in the leaf characters, resulted in over-dominance gene action.

Keywords

Epitasis
Intergenic
Over-dominance
Partial-dominance
Regression-line

Introduction

Hayman (1954) listed six assumptions as the basis for the application of additive-dominance model. These assumptions were re-emphasized by Allard (1956), who further stated that if the assumptions are valid, the points on the covariance (w_r)/ variance (v_r) graph are expected to fall on a line of unit slope. Where the regression line is significantly different from unit slope epitasis is implicated (Manga and Sidhu, 1979; Srivastava et al., 1979).

The interceps of regression lines determine the levels of dominant gene action. Where the intercept is below the origin, at origin or above the origin, the gene actions is over-dominance, complete dominance and partial dominance, respectively (Hayman, 1954; Allard, 1956; Singh and Chaudhary, 1985).

The positions of the points of parental array in relation to the origin separate the parents into either dominant or recessive parents (Hayman, 1954; Allard, 1956; Singh and Chahal, 1974; Sirohi and Choudhury, 1983; Jolliffe and Arthur, 1993). However, the positions of the parental array in relation to the sides of the regression line are used to determine the additive and non-additive gene actions of the parents. Where the parent points lie above the regression line, they are said to possess additive gene action whereas those below are said to possess non-additive gene action (Manga and Sidhu, 1979; Kaw and Menson, 1983; Sirohi and Choudhury, 1983). Sirohi and Choudhury (1983) went further to add that those arrays below the regression line implicated both non-additive and epistatic gene actions. There is dearth of information in literature regarding covariance (w_r)/ variance (v_r) graphs and additive-dominance model in castor. In the light of the above, the current study is to highlight gene action using graphic method.

Materials and methods

From a germplasm collected from Southern Guinea Savannah and characterized in the University of Agriculture Makurdi Teaching and Research Farm, five selected castor accessions were crossed in all possible combinations excluding reciprocals. An evaluation trial experiment was laid out at Akwanga and Lafia in Nasarawa State and Makurdi in Benue State. The parents and the F_1s were evaluated in a randomized complete block design of three replications. The plots were made up three rows of 1.5 m in length spaced 1.0 m apart. The rows were sown to four hills of two seeds each, spaced 0.5 m and thinned to single stand per hill. Observations were made on four plants of the middle row of each plot. Six characters *viz.*, leaf area, leaf length, number of nodes to primary panicle height to primary panicle and plant height. Hayman's (1954) method was adopted for covariance (Wr) and variance (Vr) estimates using the genotype means on MS Excel programme.

Results

The covariance (Wr)/variance (Vr) graphical analyses are presented in Figures 1 to 6. Four characters, number of leaf lobes, number of nodes to primary panicle, height to primary panicle and plant height (Fig. 3, 4, 5 and 6) have their regression coefficient b not significantly different from a unit slope. On the other hand, leaf area and leaf length (Figs. 1 and 2) have their regression coefficient significantly different from unit slope. These two latter characters and number of leaf lobes (Figs. 1, 2 and 3) have their regression lines intercept the covariance (Wr) coordinate below the origin, while the remaining three characters have their regression lines intercept the covariance (Wr) coordinate above the origin.

In the covariance (Wr)/Variance (Vr) graph Fig. 1, accessions Ac.10 and Ac.34 occurred on the regression line close to the origin, while accession Ac.3 all the accessions occurred in a straight line on the regression line. In Fig. 2, all the accessions occurred close to the origin except accession Ac.3 which occurred far away from the origin. The accessions are scattered with only accessions Ac.6 below the regression line and the rest above the regression line.

Fig. 1: Covariance (w_r)/ Variance (v_r) graphs for leaf area (cm^2) of castor in southern Guinea Savanna of Nigeria.

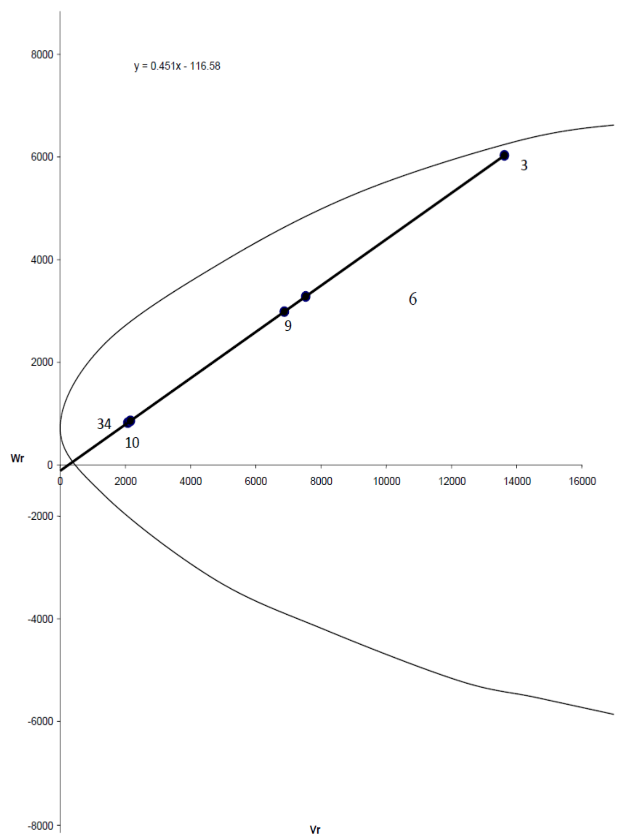


Fig. 2: Covariance (w_r)/ Variance (v_r) graphs for leaf length (cm) of castor in southern Guinea Savanna of Nigeria.

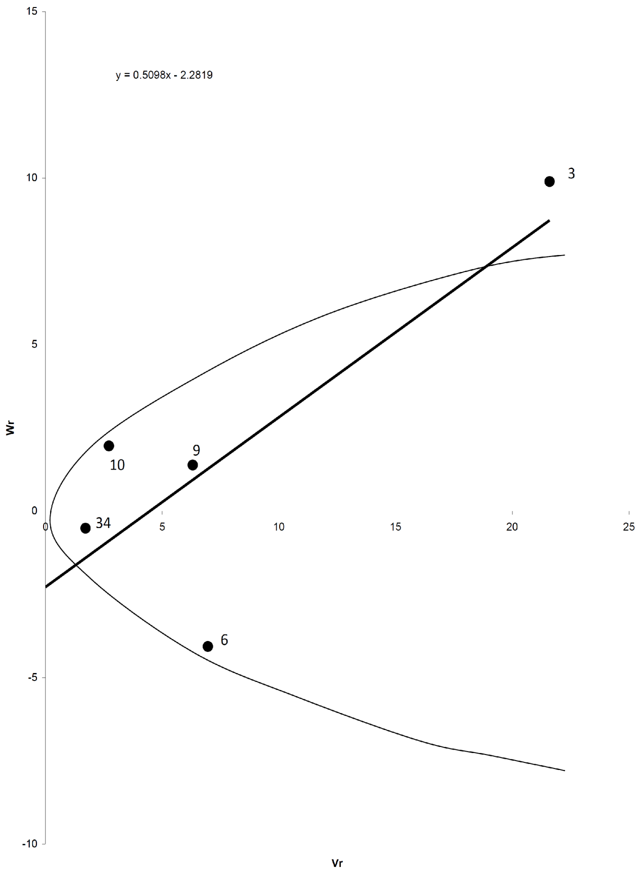
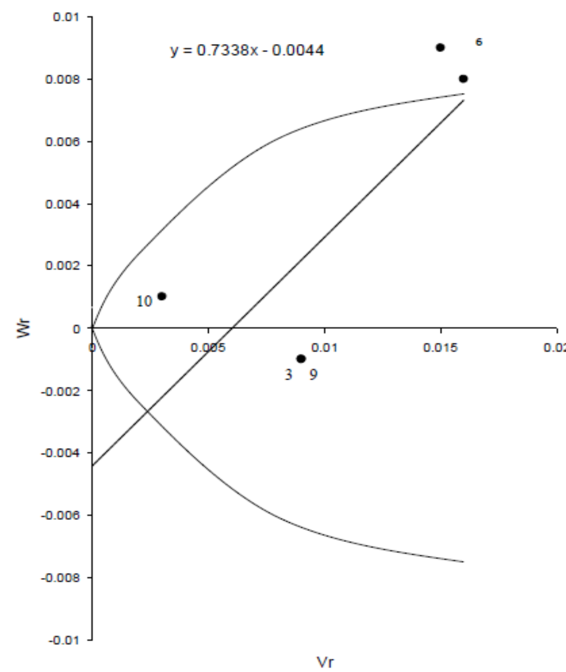


Fig. 3: Covariance (w_r)/ Variance (v_r) graphs for number of leaf lobes of castor in southern Guinea Savanna of Nigeria.



In the covariance/variance graph Fig. 3, accessions Ac.3, Ac.9 and Ac.10 occurred close to the origin, while accessions Ac.6 and Ac.34 occurred far away from the origin. The accessions all scattered with accessions Ac.3 and Ac.9 below the regression line and the rest are above the regression line. The graph of Fig. 4 shows accessions Ac.3 to be towards the origin, while accession Ac.34 to be away from the origin. All the accessions, like the case of Fig. 1, occurred on the regression line in straight line. In Fig. 5 accessions Ac.9 and Ac.34 occurred away from the origin, while the rest towards the origin.

Accessions Ac.3 and Ac.6 are above the regression line with accessions Ac.10 and Ac.34 below. The accessions fell close along the regression line. In Fig.6 accessions Ac.10 and Ac.34 occurred towards the origin with accession Ac.3 away from the origin. Accessions Ac.9 and Ac.10 are above the regression line and Ac.6 and Ac.34 below. Similar to Fig. 5, the accessions fell along the regression line.

Fig. 4: Covariance (w_r)/ Variance (v_r) graphs for number of nodes to primary panicle of castor in southern Guinea Savanna of Nigeria.

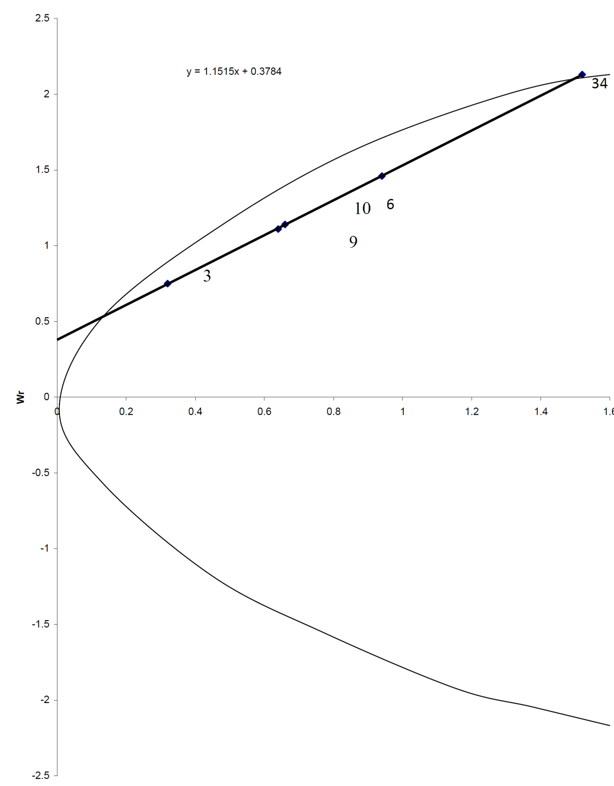


Fig. 5: Covariance (w_r)/ Variance (v_r) graphs for height (cm) to primary panicle of castor in southern Guinea Savanna of Nigeria.

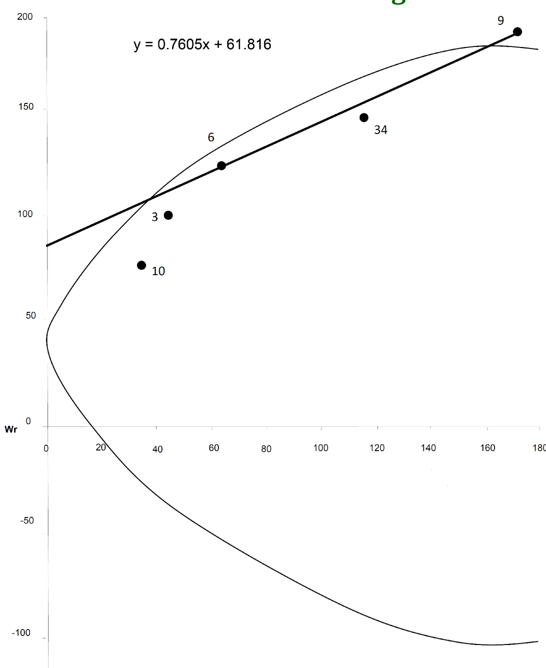
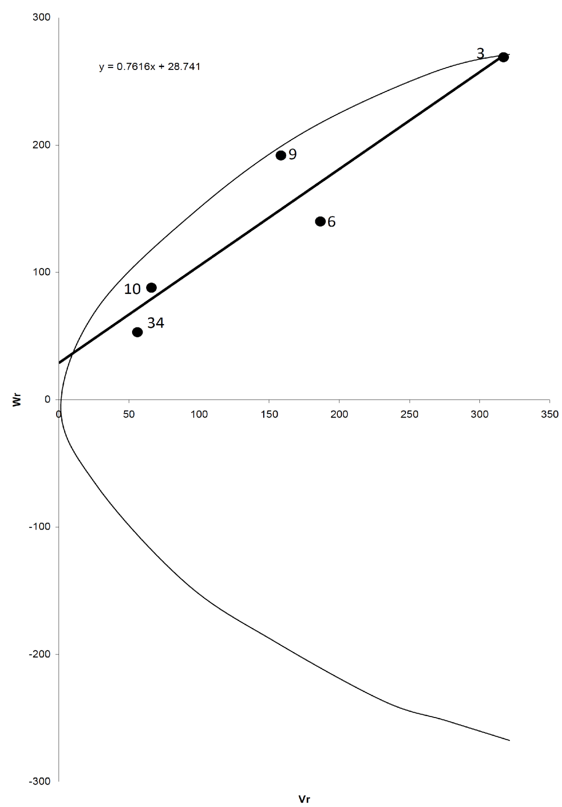


Fig. 6: Covariance (w_r)/ Variance (v_r) graphs for plant height (cm) of castor in southern Guinea Savanna of Nigeria.



Discussion

Literature citations were not available on covariance (W_r) and variance (V_r) graphical analysis in castor *per se*. However, from Hayman's (1954) assumptions, the consistency t^2 values for all the characters were non-significant. The regression coefficient b in four of the characters has fulfilled the additive-dominance model while leaf area and leaf length did not. Epitasis is implicated in this character with regression coefficients b significantly different from unit slope (Manga and Sidhu, 1979; Srivastava et al., 1979).

The covariance (W_r) /variance (V_r) graphic analyses have shown that leaf area, leaf length and number of leaf lobes exhibited over-dominance gene action as indicated by the regression lines intercepting the W_r coordinate below the origin, while partial dominance gene action was exhibited by number of nodes to primary panicle, height to primary panicle and plant height as the regression lines intercepted the Wr coordinates above the origins (Hayman, 1954; Allard, 1956; Singh and Chaudhary, 1985). The over-dominance in this trait as deduced from the W_r/V_r graph, revealed that these characters might be controlled by dominance or non-additive gene action. This agreed with the findings of Uguru and Abuka (1998) of over-dominance reported in seed yield.

Regarding the positions of the parental arrays on graphs, Ac.3 tended to have predominantly dominant genes in the number of leaf lobes character as well as characters related to earliness (Figs. 4 and 5) by occurring towards the origin of W_r/V_r graphs. On the hand Ac.3 tended to have predominantly recessive genes in the leaf area, leaf length and plant height. This agreed with the assertion of Hayman (1954) supported by Allard (1956), Singh and Chahal (1974), Sirohi and Choudhury (1983), Singh and Chaudhary (1985) and Jolliffe and Arthur (1993) that the parents were either predominantly dominant or preponderantly recessive when they occur close to or far away from the origin, respectively. Though accession three (Ac.3) possessed mostly recessive genes for leaf area, leaf length and plant height, while in leaf lobes where Ac.3 was one of the dominant gene parents, the regression line b tended to unity unlike the former characters. This showed Ac. 3 to possess intergenic interaction (*epistasis*).

Most genes, as regard to the parental position on the sides of regression line, were additive in leaf length and number of leaf lobes with few non-additive genes. There were equal additive and non-additive genes in plant height and height to primary panicle. Citation of additive and non-additive genes, based on were made by Manga and Sidhu (1979), Kaw and Menson (1983), and Sirohi and Choudhury (1983). Sirohi and Choudhury (1983) went further to add that those arrays below the regression line not only exhibit non-additive and epistatic gene actions. The few non-additive genes in the two leaf characters had profound effect over the additive genes that resulted in over dominance gene action.

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