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Combining ability and gene action in a diallel cross of eight sesame genotypes

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Abstract

An 8 x 8 diallel cross mating design with the parents and F_1s excluding the reciprocals was used to estimate gene action and combining ability analysis for yield and some yield components in sesame (*Sesamum indicum*). These genotypes were evaluated at the National Semi-Arid Resources Research Institute (NaSARRI), Serere, Uganda. The investigation was carried out during the second season of 2013. Most of the sesame genotypes available in Uganda have low seed yields. A number of yield related components contribute to yield. The genes underlying these genotypes have not been documented. The present study was conducted to estimate the combining ability for twelve traits viz. days to maturity, plant height, 1000 seed weight, height of first capsule on the main stem and yield per plant among others. The genetic variance of combining ability was separated into general (GCA) and specific (SCA) combining ability variance components. Baker's ratio, coefficients of genetic determination (CGD) were determined for narrow and broad sense. Effects due to GCA and SCA were analysed. High GCA effects were recorded for days to flowering (31.925***), plant height (105.7*), number of branches per plant (1.709*), number of capsules on main stem (22.417*), number of capsules on branches (178.01**), length of the capsule fruitinf zone (191.17***), capsule length (0.117***) and capsule width (0.0028*). This is due to additive gene action. SCA showed significant effect for only the number of capsules on branches (99.96*) and yield per plant (2.97*). Baker's ratio was high for most of the traits except for yield per plant (0.233). CGDbs was also high for most of the traits except for days to maturity (0.064), plant height (0.346), capsules on main stem (0.358) and capsule width (0.286).

Key words: Combining ability, diallel analysis, gene action, *Sesamum indicum*

Résumé

Une conception diallèle 8 x 8 croix d'accouplement avec les parents et les F_1s à l'exclusion des réciprocités a été utilisé pour estimer l'action des gènes et combinant la capacité de l'analyse pour le rendement et des composantes du rendement du sésame *(Sesamum indicum).* Ces génotypes ont été évalués à l'Institut national de semi-arides des ressources de recherche (NaSARRI), Sérère, en Ouganda. L'enquête a été réalisée au cours de la deuxième saison de 2013. La plupart des génotypes de sésame disponibles en Ouganda ont de faibles rendements de semences. Un certain nombre de rendements liés à des composants contribuent à la production. Les gènes qui sous-tendent ces génotypes n'ont pas été documentés. La présente étude a été menée pour évaluer l'aptitude à la combinaison de

douze traits, à savoir, les jours de la maturité, la hauteur de la plante, le poids de 1000 graines, la hauteur de la première capsule sur la tige principale et le rendement par plante entre autres. La variance génétique de combiner la capacité a été séparé en général (GCA) et spécifique (SCA), combinant la capacité de la variance des composantes. Le ratio de Baker, les coefficients de détermination génétique (CGD) ont été déterminées pour le sens étroit et large. Les effets dus à GCA et SCA ont été analysés. Les effets de GCA supérieur ont été enregistrés pour les jours à la floraison (31,925 ***), la hauteur de la plante (105,7 *), le nombre de branches par plante (1,709 *), le nombre de capsules sur la tige principale (22,417 *), le nombre de capsules sur les branches (178,01 **), la longueur de la zone de la capsule fruitière (191,17 ***), la longueur de la capsule (0,117 ***) et la largeur de la capsule (0,0028 *). Cela est dû à l'action de gène additif. Le SCA a montré d'effet significatif seulement pour le nombre de capsules se trouvant sur les branches (99,96 *) et le rendement par plante (2.97 *). Le ratio de Baker était élevé pour la plupart des traits sauf pour le rendement par plante (0,233). Le CGD était également élevé pour la plupart des traits sauf pour les jours à maturité (0,064), la hauteur de la plante (0,346), des capsules sur la tige principale (0,358) et la largeur de la capsule (0,286).

Mots clés: La combinaison de capacité, analyse diallèle, l'action des gènes, *Sesamum indicum*

Background

Sesame (*Sesamum indicum* L.) is one of the ancient oilseed crop grown in Uganda. It is known as the queen of oilseeds in view of its oil and protein which are of very high quality. In uganda, productivity is low as compared to most of the African countries. This is basically due to lack of improved sesame cultivars thus; forcing farmers to cultivate mainly the landraces which are inferior in yield and other yield attributes. The genetic makeup of genotypes for quantitative inherited traits can be well understood by the study of genetic parameters. The present study was conducted to estimate the combining ability for twelve traits.

Literature review

Combining ability analysis is a common tool used in the breeding programmes for testing the performance of lines in hybrid combinations and also for characterising the nature and magnitude of gene action involved in the expression of quantitative traits. General combining ability (GCA) of a line refers to the average value of a line estimated on the basis of its performance when crossed with other lines (Falconer, 1989). The performance of a particular cross can deviate from the average general combining ability of the two parental lines. This deviation is defined as the specific combining ability (SCA). General and specific combining abilities represent the major division of types of gene action for quantitative traits. General combining ability is largely due to additive genetic effects and additive x additive epistasis, while specific combining ability is largely a function of non additive dominance and other types of epistasis. Combining ability analysis has been utilised to know the nature and extent of gene action controlling the inheritance of yield and its components for obtaining better recombinants (Saravanan and Nadarajan, 2003). Raja Ravindran and Amirtha Deva

Raghinam (1996) observed that the variances due to general and specific combining ability and reciprocal effects were significant for all the characters. Both additive and non-additive genetic variances were found to be important for all the nine characters studied.

Study description

Eight diverse sesame genotypes including local and exotic selected lines that were previously characterised morphologically in the breeding programme at the National Semi-Arid Resources Research Institute (NaSARRI), Serere, Uganda and showed contrasting traits were crossed in an 8 x 8 diallel mating design without the reciprocals resulting in 28 F_1s. These hybrids along with their parents (8) totaling to 36 genotypes were grown in a randomised block design with three replicationsin single rows of 2 m long. The spacing was 30 x 10 cm. The trial was planted at NaSARRI in 2013. The experimental design was a diallel mating design Method 2, Model 1 (Griffing, 1956). The data recorded were: number of days to 50% flowering, days to maturity, number of primary branches per plant, height of first branch on the main stem, height of first capsule on the main stem, length of the capsule formation zone, number of capsules on the branches, number of capsules on the main stem, number of capsules per plant, plant height, number of seeds per capsule, 1000 seed weight, capsule length, capsule width and seed yield per plant. Method 4, Model 1 of Griffing (1956) was used for the analysis of gene action.

Research application

General combining ability. High GCA effects were recorded for days to flowering, height of first capsule and branch, number of branches per plant and capsule length. No significant GCA effects were recorded for days to maturity and yield per plant. Sesim 1 was the best parent with the highest number of significant GCA effects followed by SPS1438-1-6-4. Sesim2//5181 and 4036-1-10-2 had no any positive or negative significance for any trait but phenotypically, they had been recorded to be tolerant to gall midge pest and good yield. Specific combining ability

Genotype Ajimo A1-5 x Renner 1-3-1-1 had positive significant SCA effect for height of first branch (10.83). Ajimo A1-5 x Sesim2//5181 had negative significant effect for capsules on branches (-14.88) and yield per plant (-2.62). Sesim1 x Ajimo A1-5 recorded positive significant SCA effect for yield per plant (2.28). Sesim 1 x Sesim 2 had positive significant effect for days to flowering (1.591), number of branches per plant (0.901), number of capsules on branches (20.75) and yield per plant (2.42). These two crosses could be good hybrid for yield performance as number days to flowering, number of branches per plant; and number of capsules on branches are positively correlated to yield.

Mean squares due to GCA and SCA. Highly positive significant effect was recorded for GCA on days to flowering, height of first capsule, plant height, number of branches per plant, number of capsules on main stem and branches, length of capsule fruiting zone, capsule length and width. This is due to preponderance of additive gene action. No significant SCA effects were observed for days to maturity, height of first branch and yield per plant. SCA

showed significance for capsules on branhes and yield per plant thus indicating non –additive gene action for those traits.

Baker's ratio was high for most of the traits except yield per plant (0.233). CGDbs was higher for most traits except days to maturity (0.064), plant height (0.346), capsules on main stem (0.358) and capsule width (0.286). CGDns was high for most traits except days to maturity (0.064), height of first branch (0.477), plant height (0.346), capsules on main stem (0.295), capsules on branches (0.273), capsules fruiting zone (0.49), yield per plant (0.133) and capsule width (0.286) and capsule width (0.286).

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