

Conference Paper

Diallel Analysis and Heterosis of Yield and Yield Components in Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

Groundnuts are an important agricultural commodity and a preferred raw material for the food industry. This study aimed to generate information on the extent of heterosis over the best parent and mid-parent in groundnut for yield traits and components. The research was conducted at the Research Farm of PT. Garudafood Putra Putri Jaya Tbk., located in Pati, Central Java, from January to December 2022. Five selected parents (Garuda Biga, Litbang Garuda 5, LSU, LSB, CBT) were used as breeding materials. This study was conducted according to Griffing I method with a complete diallel (parents, F1, and F1R) and model 1 (fixed effect). These parents, F1 and F1 reciprocal, were grown in a randomized block design with three replications. The heterosis mid parents (MP) value is significant in the characters number of mature pod, number pods per plant, weight mature pod, and weight per immature pod plants in combination crosses P4 x P5, P5 x P4, whereas for combination the crosses P1 x P3 and P3 x P1 have heterobeltiosis value such as heterosis best parents (BP) is numbers pod seed three and percentage seed three. The best cross-breeding combination for pod characters is hoped to become a candidate genotype that can be used to increase productivity and meet the needs of the peanut processing industry.

Keywords: Industrial raw materials, three-seeded peanuts, completed diallel, heterosis, heterobeltiosis

Introduction

In accordance with consumer preferences for healthful foods, the industrial demand for agricultural raw materials will likely increase. One choice for a nutritious food source is peanuts because they are packed with essential nutrients. Peanuts have a nutritional value of 44.2–56.0% fat, 17.2–28.8% protein, and 21% carbohydrate (Yulfianti et al, 2015). According to Trustinah and Kasno (2012), peanut fat has the largest fat content of any nut, even when compared to several other food crop commodities. Unsaturated fatty acids, including oleic and linoleic acids, make up between 76 and 86 percent of peanut fat.

The genetic material collection must be enhanced in order to produce peanuts with qualities that satisfy market expectations. In order to attain the required traits, more selection may be made within the peanut collection, the more genetic material there is. Genetic recombination of genetic resources with distinct traits can result in the production of improved varieties. By choosing suitable parents, directed crosses are used to accomplish recombination. Several mating designs, including the diallel method, North Carolina (NC) designs I, II, and III, and the line x tester, can be used to test for combining ability (Fasahat et al., 2016).

As stated by Ezin et al. (2023), the diallel analysis method is specifically intended to evaluate genetic design, estimate parameters that are helpful in choosing parents for crossing, and describe the genetic impacts involved in determining plant capabilities. According to Mutoni and Shimelis (2020), a diallel mating design is one that is utilized to ascertain the general and specific combining capacities of

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crossed lines. This diallel design can identify the potential of both male and female parents, and it can also provide information on maternal and non-maternal impacts for reciprocal effects (Skrøppa et al., 2023). Griffing developed a linear model that is commonly used to discover hybrid combinations, and this mating design is based on that model (Kaushik & Dhaliwal, 2018).

Heterosis is the improvement of the traits of crossbred plants or animals over the average of the traits of the two parents (Allard, 1960). Growth, yield, resistance to pests and diseases, and other traits belong to the many that may represent heterosis (Falconer & Mackay, 1996). The number of pods, pod weight, seed weight, pod size, and seed size are some of the yield components that can be improved to increase the genetic yield potential of peanuts (Sinare et al., 2024). Breeding for better and high-yielding peanut cultivars has been impeded by a paucity of information about yield genetics and yield components (Alam et al., 2013). The purpose of this study was to generate information regarding the degree of heterosis over the best and midparent groundnuts for yield traits and components.

Material and Methods

Planting of material parents in January – April 2022, then producing F1 population based on diallel mating design was carried out in May – August 2022, and planting of parents, F1, and F1 reciprocal in September – December 2022 at the Experiment Garden of PT. Garudafood Putra Putri Jaya Tbk., Keboromo, Tayu, Pati, Central Java. The materials used were 25 peanut genotypes from 5 selected parents (Garuda Biga (P1), Litbang Garuda 5 (P2), LSU (P3), LSB (P4), CBT(P5)), namely the parents of genotypes F1 and F1. The fertilizer used was NPK Customized fertilizer 8: 16: 21 with a dose of 200 kg/ha (0.8 gr/polybag), dolomite fertilizer with a dose of 500 kg/ha (2 gr/polybag), organic fertilizer using goat manure with a dose of 1500 kg/ha (6 gr/polybag), label. The tools used were analytical scales, vernier calipers, measuring instruments, and a camera for documentation. This study was conducted with a three-replication experimental design and the Griffing 1 method, namely complete diallel with fixed effects, heterosis of the middle parent, and the best parent is used for TNAUSTAT analysis.



Figure 1. Generative stage parents, F1 and F1 reciprocal (Left) 1st and 2nd replication (Right) 3rd replication

Results and Discussion

Results

The general combining ability analysis for Parent 1 (Garuda Biga) had good GCA in terms of the number of branches, number of pods with three or more seeds, and percentage of pods with three or more seeds. Parent 2 (Litbang Garuda 5) had good GCA in terms of biomass weight, number of pods per plant, and plant height. Parent 3 (LSU) has good GCA in mature pod weight, weight of each mature pod, immature pod weight, weight of each immature pod, number of immature pods, dry immature pod weight, percentage of shelling of mature pods, percentage of shelling of immature pods, and dry weight of immature pods. Parent 4 (LSB) had good GCA weight per immature pod, percentage of pods with three or more, and number of pods per plant. Parent 5 (CBT) had good GCA in terms of number of pods per plant, total dry pod weight, mature pod weight, pod weight per plant, and number of mature pods. The analysis results showed good specific combining ability in several characters of the P4 x P5, P5 x P4,

P1 × P3 × P3 × P1, P2 × P3, P3 × P2, P1 × P2 × P2 × P1, P3 × P5, and P5 × P3 combination crosses. Combination crosses with good sca character, namely of the number of mature pods, total number of pods per plant, number of three-seeded pods, and percentage of three-seeded pods, as well as good pods weight, were obtained from P4 × P5 and P5 × P4. As for the parent, the parent with the best GCA value for the corresponding character was CBT.

Heterosis is frequently utilized in plant breeding to boost plant productivity, as seen in hybrid rice, corn, and other horticulture crops (Hallauer et al., 1981). Heterosis has been extensively documented in peanuts for a number of variables, including seed yield, 100-seed weight, and other yield components (Upadhyaya et al., 2012).

The heterosis (MP) value is significant in the number of mature **pods**, number **of** pods per plant, weight **of** mature pod, and weight per immature pod plants in combination crosses P4 × P5, P5 × P4, whereas for combination, the crosses P1 × P3 and P3 × P1 have heterobeltiosis (BP) is numbers pod seed three and percentage seed three.

Conclusion

The Garuda Biga, LSU, and CBT showed the best overall general combining ability for yield and yield-related traits. The crosses CBT × LSB and LSB × CBT exhibited the highest specific combining ability for the number of three-seeded pods and the percentage of three-seeded pods. For the branch number, the LSB × CBT combination produced the highest pod number and pod weight. In the P4 × P5 and P5 × P4 crosses, significant mid-parent heterosis was observed for the number of mature pods, number of pods per plant, weight of mature pods, and weight of immature pods. In contrast, in the P1 × P3 and P3 × P1 crosses, significantly better-parent heterosis (heterobeltiosis) was detected for the number of three-seeded pods and the percentage of three-seeded pods.

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References

- Allard, R.W. (1960). *Principle of plant breeding*. Wiley & Sons Inc, New York London Sidney.
- Alam, M. K., Nath, U. K., Azad, M. A. K., Alam, M. A., & Khan, A. A. (2013). Combining ability analysis for yield and yield contributing traits of groundnut. *Journal of Science and Technology* 11(2013), 106-111
- Ezin, V., Tossou, T. A. W., Chabi, I. B., & Ahanchede, A. (2023). Diallel analysis of cowpea (*Vigna unguiculata* (L.) Walp.) genotypes under water deficit stress. *BMC Plant Biology*, 2023(23), 539. <https://doi.org/10.1186/s12870-023-04508-0>
- Falconer, D., & Mackay, T. F. (1996). *Introduction to quantitative genetics*. Fourth Edit.
- Fasahat, P., Rajabi, A., Rad, J. M., & Derera, J. (2016). Principles and utilization of combining ability in plant breeding. *Biometrics Biostat. Int. J.*, 4(1), 1-22. doi:10.15406/bbij.2016.04.00085.
- Hallauer, A.R.M.F. (1981). *Quantitative Genetics in Maize Breeding*. 2nd ed. IowaState Press, Iowa.
- Trustinah, T., & Kasno A. (2012). Karakterisasi kandungan asam lemak beberapa genotipe kacang tanah. *Jurnal Penelitian Pertanian Tanaman Pangan*, 31(3). Doi:10.21082/jpptp.v31n3.2012.p145-151.
- Kaushik, P., & Dhaliwal, M. S. (2018). Diallel analysis for morphological and biochemical traits in tomato cultivated under the influence of tomato leaf curl virus. *Agronomy* 8(8). doi: 10.3390/agronomy8080153.
- Muthoni, J., & Shimelis, H. (2020). Mating designs commonly used in plant breeding: A review. *Aust. J. Crop Sci.*, 14(12), 1855–1969. doi: 10.21475/ajcs.20.14.12.p2588.
- Sinare, B., Desmae, H., Nebie, B., Konate, B., Eleblu, J., Miningou, A., Traor'e A, Ofori, K., & Zagre, B. (2024). Diallel analysis, maternal effect and heritability in groundnut for yield components and oil content. *J. Heliyon*, 10(2024), e33379. <https://doi.org/10.1016/j.heliyon.2024.e33379>
- Skrøppa, T., Solvin, T. M., & Steffenrem, A. (2023). Diallel crosses in *Picea abies* III. Variation and inheritance patterns in nursery trials. *Silvae Genetica*, 72, 49–57.

- Upadhyaya, H. D., G. Mukri, H.L. Nadaf, and S. Singh. (2012). Variability and stability analysis for nutritional traits in the mini core collection of peanut. *Crop Sci.*, 52(1), 168–178. doi: 10.2135/cropsci2011.05.0248.
- Yulifianti, R., Santosa, B. A. S., & Widowati, S. (2015). Teknologi pengolahan dan produk olahan kacang tanah. *Monograf Balitkabi*, 13.