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Genetic Parameters of Quantitative Characters OF Self-Produced Lines of the Fifth Generation of Corn Plants in Dry Land

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Abstract: This study aimed to determine the genetic diversity, heritability, and correlation of quantitative traits of the fifth generation (S5) of selfing lines of maize plants. The experiment was conducted in the dry land of Gumantar village, North Lombok, from February to May 2025. The design used in this experiment was a randomized block design. The number of treatments was 30 S5 lines. Each treatment was repeatedThe experiment was conducted twice, resulting in 60 experimental units. Eleven quantitative characters were observed, consisting of growth variables, yield components, harvest age, and yield. The experimental data were analyzed using analysis of variance at a significance level of five percent. The correlation between characters and yield was calculated using Pearson rank correlation. The results showed that six quantitative characters of the S5 line had narrow genetic diversity and six characters had moderate criteria; with genetic diversity coefficients ranging from 1.56 for harvest age and 13.02 for yield. The broad-sense heritability of 1,000-grain weight was high, six characters were moderate, and the rest were narrow. The yield character was strongly correlated with the harvested dry cob weight per plant; with cob length being moderately correlated; four characters were weakly correlated, and the other characters were not correlated with yield. The plants selected to form the sixth selfing generation were taller plants with narrower leaf angles and flowering simultaneously.

Keywords: Corn plants; Correlation and self-crossing; Heritability

Introduction

Drylands have great potential for corn development. Characteristics of corn varieties suitable for drylands include tolerance to drought stress, super early/early maturing, resistance to important pests and diseases, and high yields (Adriani et al., 2015 and Azrai et al., 2016). These corn varieties can be developed through plant breeding programs. According to Azrai et al. (2016), the success of a breeding program depends on the availability of genes carrying desired traits and the level of genetic diversity in the breeding material. Sudika and Anugrahwati (2021) have conducted hybridization to establish a base population for the development of superior corn varieties that are tolerant to drought stress, have a medium leaf angle (30-350), and high yields. Hybridization was carried out between Sinta Unram, which is super early maturing and tolerant to drought stress, and the hybrid varieties NK212 and NK7328. Both varieties have the advantage of high yield potential and a medium leaf angle (30-350). The F2 population resulting from the hybridization has been estimated to have genetic variation components by Adeputri et al., 2022). The estimation results show that the dominant variation is greater than the additive variation for the leaf angle, harvest age and yield characters, so it is recommended to form hybrid varieties.

Hybrid varieties can significantly increase production in both intensification and extensification programs. This is due to the high yield potential of hybrids, namely 10-12 tons per hectare (Cyplik et al.,

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2022). Hybrid varieties are formed from two or more pure lines. To obtain pure lines, several generations of selfing are carried out until a homozygous genotype is obtained; generally 5 to 6 generations. (Widanni & Sugiharto, 2019). *Selfie*causing internal cross-pressure; which results in deviations in plant appearance compared to the previous population (Kisman, 2023). The results of research by Hikmah et al. (2023), that most of the first generation of selfing (S1), there was a decrease in quantitative characters including later flowering age, shorter plants and lower yield and yield components compared to the F2 population. In the second generation of selfing (S2), the same thing also occurred, namely a decrease in quantitative characters, as stated by Pratiwi et al. (2024). Selfing has been carried out in the third generation (S3), fourth (S4) and fifth generation (S5). Selfing will be continued to form the sixth generation (S6) using the S5 line material. Selfed plants are plants that have characters with moderate or broad genetic diversity. The wider the genetic diversity, the easier it is to obtain superior genotypes (Sudika et al., 2022).

The heritability of these characters is also classified as moderate or high. Characters with high heritability values indicate that genetic factors play a significant role in the formation of plant traits, making them readily inherited from one generation to the next (Widyapangesthi et al., 2022). Furthermore, these traits should correlate with yield. Quantitative traits that meet these criteria are unknown. Therefore, this study aimed to determine genetic diversity, broad-sense heritability, and correlation with yield of other quantitative traits in the fifth selfing generation of dryland maize plants.

Method

This study used an experimental method to assess the genetic parameters of quantitative traits of S5 lines. The experiment was conducted in dry land with irrigation sources derived from drilled wells. The experimental location was in Amor-Amor hamlet, North Lombok Regency. The experiment began in February and lasted until May 2025. The environmental design used in this experiment was a randomized block design, with 30 S5 lines as treatments. Each treatment was replicated twice, resulting in 60 experimental units.

The experiment included seed preparation, land preparation, planting, fertilization, thinning, weeding and hilling, pest and disease control, irrigation, and harvesting. The seeds to be planted were first treated with Saromyl 35 SD at a dose of 5 g/kg of seed. Land preparation was carried out by plowing and harrowing once each, then the land was leveled. The experimental plot was divided into two blocks with each block measuring 5 x 36 m. The planting distance used was 20 x 60 cm with a distance between blocks of 1 m. Planting was carried out by planting two seeds per hole. Each treatment was planted in two rows; each with 25 holes. Furadan 3 G was given in the planting hole at a dose of 20 kg/ha. A hole for a mixture of Phonska and Urea fertilizers was made to the left of the planting hole. The first fertilization was carried out at planting time with a dose of Phonska 150 kg/ha and Urea 100 kg/ha. The planting holes that have been filled with seeds and Furadan are covered with Petroganik fertilizer at a dose of 600 kg/ha.

Thinning was carried out at 12 days old, leaving one plant per hole. Weed control was carried out by spraying the herbicide Calaris 350 SC at 14 days old at a dose of 75 cc/16 l of water. Follow-up fertilization and hilling were carried out at 28 days old at the same dose as the first fertilization. Fertilization was carried out by making holes between plants in rows. Irrigation was not carried out, because it rained during the experiment. Pest control was carried out by spraying the insecticide Meurtieur 30 EC at 21, 38, and 60 days after planting. Harvesting was carried out when at least 85 percent of the plants in each treatment had met the harvest criteria, with dry husks and hardened seeds.

The variables observed included growth variables (plant height, number of leaves per plant, leaf angle, stem diameter, leaf area), harvest age, yield components (cob length, cob diameter, dry cob weight per plant, weight of 1,000 seeds) and yield (dry kernel weight per plant).

The experimental data were analyzed using analysis of variance at a 5 percent significance level. Based on the mean square values in the analysis of variance table, genetic variance, phenotypic variance, and broad-sense heritability were calculated. The coefficient of genetic variation for each trait was then calculated.

The coefficient of genetic diversity (GCD) is calculated using the formula proposed by Ujianto et al. (2020), as follows:

$$KKG\ (\%) = (SdG / \mu) \times 100\ \% \quad (1)$$

where KKG is the genetic diversity coefficient; SdG is the standard deviation of total genetic variation and μ is the general mean. Genetic diversity categories are based on the value of the genetic diversity coefficient, following the criteria of Halide et al. (2020), namely broad genetic diversity, if the KKG value is ≥ 14.00%); Medium, 5.00% ≤ 14.00% and narrow genetic diversity, if the KKG value is < 5.00%.

Broad sense heritability (H2) was calculated according to the formula proposed by Ujianto et al., (2020) as follows:

$$H2 = (\sigma 2G / \sigma 2P) \times 100\% \quad (2)$$

with H2, broad sense heritability: σ2G, total genetic variance: σ2P phenotypic variance. Total genetic variance and phenotypic variance are obtained by the formula:

$$\sigma 2G = (KTP - KTE)/r \text{ and } \sigma 2P = \sigma 2G + KTE \quad (3)$$

with KTP, being the mean square of the treatment and KTE, being the mean square of the error in the analysis of variance and r, being the number of replications. Broad sense heritability (H2) values are classified following Syukur et al. (2012) into three categories, namely, low if H2 < 20; medium, 20-50% and high H2 if > 50%.

The correlation coefficient value was tested using Spearman's rank correlation. Based on the correlation coefficient value, correlation criteria were created. The correlation criteria were categorized into three categories: weak, moderate, and strong correlations for significantly different correlation coefficient values.

Result and Discussion

Genetic Diversity

Genetic diversity is obtained by categorizing the genetic diversity coefficient (GCC) values. The genetic diversity categories for all observed quantitative characters are presented in Table 1.

Table 1. Genetic diversity coefficient (GCC) values for quantitative characters of the S5 line of corn plants in dry land

Observed characters	KKG Value (%)	Genetic diversity criteria
Plant height	5.93	Currently
Number of leaves per plant	4.62	Narrow
Leaf angle	7.01	Currently
Stem diameter	7.52	Currently
Leaf area	4.32	Narrow
Harvest age	1.56	Narrow
Length of the cob	4.05	Narrow
Cob diameter	4.98	Narrow
Weight of dry cobs harvested per plant	8.52	Currently
Weight of 1,000 seeds	13.02	Currently
Yield (weight of dry kernels per plant)	7.32	Currently

Table 1 shows that no quantitative traits exhibited broad genetic diversity. Moderate genetic diversity was found for plant height, leaf angle, stem diameter, dry cob weight per plant, 1,000-grain weight, and yield (dry kernel weight per plant). The number of leaves per plant, leaf area, harvest age, cob length, and cob diameter exhibited narrow genetic diversity.

The observed quantitative traits are influenced by genetic factors, the environment, and the interaction between the two (Bocianowski et al., 2019; Wardyn et al., 2007). Variation in genetic factors can be quantitatively measured using the coefficient of genetic diversity (CV) (Ujianto et al., 2020). This coefficient value is used to estimate the extent of genetic diversity in a plant population. A high CV value indicates broad genetic diversity, and vice versa (Heryanto et al., 2022). The greater the level of genetic diversity in a population, the more diverse the traits, thus the greater the opportunity to obtain individuals with superior traits that can be utilized in selection programs (Hidayat and Latif, 2020; Sudika et al., 2021). The results of the study showed that the genetic diversity of the observed traits was classified as narrow and moderate, and no traits with broad genetic diversity were obtained.

Narrow genetic diversity was obtained in the number of leaves per plant, leaf area, harvest age, cob length, and cob diameter. while the medium category is found in plant height, leaf angle, stem diameter, dry cob weight per plant, weight of 1,000 grains and yield (dry kernel weight per plant. Narrow genetic diversity shows the results of previous research that examined the genetic diversity of the third selfing generation (S3), it was found that the dry kernel weight (yield) had wide genetic diversity. In this third selfing generation, the same results were obtained, namely the medium category for plant height characters, leaf angle and dry cob weight per plant.) (Narda et al., 2025). Genetic diversity in the narrow and medium categories in the fifth generation (S5) occurred because selfing had been carried out for five generations, so that the S5 line was close to homozygous. This is in accordance with the opinion Widanni & Sugiharto (2019) found that homozygous lines will be obtained in the fifth to sixth selfing generations. Based on the results of this S5 line study, plant height and leaf angle are potential criteria for selecting plants for selfing to form the sixth generation. Plant selection is carried out immediately before pollination. Plants that meet the requirements for selfing must flower simultaneously, meaning the female flowers are ready for pollination and still contain pollen.

Heritability

Heritability is an important genetic parameter in plant breeding because it determines the extent to which a trait can be inherited and improved through selection. A low heritability indicates that environmental factors have a greater influence on plant performance, making the trait less effective as a selection criterion. The environmental factor influencing this is dryland. Dryland has limited water and nutrient availability in the soil (Aprianti and Kusmiyati, 2021 and Farhah et al., 2022). The heritability of a trait has a significant impact on the methods chosen for population improvement, inbreeding, and other aspects of selection (Azima, et al., 2024). The results of the broad-sense heritability calculation for quantitative traits of line S5 are presented in Table 2.

Table 2 shows that broad-sense heritability is classified as high, obtained at a weight of 1,000 seeds. Characteristics of plant height, number of leaves per plant, leaf angle, stem diameter, harvest age, and yield are classified as medium; while the low category is obtained for leaf area, ear length, ear diameter, and dry ear weight per plant.

Table 2. Genetic variance (σ2G), phenotypic variance (σ2P) and broad sense heritability (H2) values Quantitative characteristics of S5 line of corn plants in dry land

Observed characters	σ2G value	σ2P value	H2 value (%)	Heritability criteria
Plant height	46.36	120.06	38.61	Currently
Number of leaves per plant	0.16	0.47	33.81	Currently
Leaf angle	5.96	21.43	27.82	Currently
Stem diameter	1.24	3.41	36.46	Currently
Leaf area	144.38	732.95	19.70	Low
Harvest age	1.43	5.95	24.08	Currently
Length of the cob	0.23	2.27	9.93	Low
Cob diameter	2.37	18.48	12.81	Low
Weight of dry cobs harvested per plant	44.37	253.06	17.53	Low
Weight of 1,000 seeds	280.08	350.73	79.85	Tall
Yield (weight of dry kernels per plant)	23.11	71.24	32.44	Currently

Characters with high heritability levels indicate that genetic factors have a stronger influence on their performance (Rafsanjani, et al., 2023). Plants selected for selfing should have high or moderate broad-sense heritability. The weight of 1,000 seeds has a high heritability; however, it cannot be used as a criterion for determining plants to be selfed because this character is obtained after harvest. Therefore, the broad-sense heritability criterion is reduced to a moderate category. Plant height, number of leaves, and leaf angle of the S5 lines have moderate broad-sense heritability. These three characters have the potential to be used as selection criteria for obtaining plants to be selfed. The same result was obtained by Narda et al. (2025) on the S3 lines, that plant height and leaf angle have moderate broad-sense heritability. Sudika et al. (2025) also obtained the same result, that plant height and number of leaves per plant of the S2 line have moderate heritability. According to Priyanto, et al. (2018) showed moderate heritability, indicating that genetic and environmental factors contribute equally to the appearance of a character. Broad-sense heritability of the S5 line was low, with leaf area, cob length, cob diameter, and dry cob weight harvested per plant ranging from 9.93% to 19.70%. Narda et al. (2025) found the same results for cob length and dry cob weight harvested per plant. Sudika et al. (2025a) found the same results for cob diameter. The appearance of these characters is largely influenced by environmental factors. Characters with low heritability estimates will result in a low selection response, making selection less effective (Afandi and Samudin (2022). The environmental factor that influences this is rainfall. The S5 line was tested from February to May 2025 in dry land. Rainfall from planting to the vegetative phase was high, resulting in excess water for the corn plants. This significantly disrupted the growth of the corn plants.

Correlation Between Characters and Results

The closeness of the relationship between yield characters and other quantitative characters is presented in Table 3.

Table 3. Correlation coefficient values between yield characters and other quantitative characters

Observed characters	Correlation coefficient value	Correlation criteria
Plant height	0.383	Weak correlation
Number of leaves per plant	0.189	Not correlated
Leaf angle	0.257	Weak correlation
Stem diameter	0.001	Not correlated
Leaf area	-0.108	Not correlated
Harvest age	-0.074	Not correlated
Length of the cob	0.561	Moderate correlation
Cob diameter	0.324	Weak correlation
Weight of dry cobs harvested per plant	0.859	Strong correlation
Weight of 1,000 seeds	0.445	Weak correlation

Description: Uncorrelated, the correlation coefficient value is <0.254; weak correlation, 0.254-0.503; moderate, 0.504 – 0.753 and strong correlation, >0.753.

Table 3 shows that the yield character is strongly correlated with the dry cob weight harvested per plant and moderately correlated with cob length.Plant height, cob diameter, and 1,000-grain weight were weakly correlated with yield; while number of leaves per plant, leaf angle, stem diameter, leaf area, and harvest age were not correlated with yield.

The level of closeness of the relationship (correlation) between quantitative characters and yield characters can be used as a consideration in determining the magnitude of changes in yield, if the plants to be...*disselfing*selected based on specific traits. Changes in certain traits, when selected against other traits, are known as correlated responses (Bazuki, 2005). Characters that can be selected immediately before pollination include plant height, number of leaves per plant, leaf angle, stem diameter, and leaf area. Plant height has a weak positive correlation with yield; while the other four traits do not correlate with yield. Harvest age and leaf angle do not correlate with yield. Sudika et al. (2024) obtained similar results for plant height and dry cob weight at harvest. In this study, plant height also had a weak positive correlation with yield in the S4 line; while dry cob weight at harvest was strongly correlated with yield. This indicates that the taller the selected plant, the smaller the yield increase. The same result was found for harvest age in the S3 corn line by Sudika et al. (2025b).

Conclusion

The conclusion of the research results, that as many as 6 quantitative characters of the S5 line have narrow genetic diversity and 6 characters of medium criteria; with a genetic diversity coefficient ranging from 1.56 at harvest age and 13.02 for yield. The broad sense heritability of 1,000 grain weight is classified as high, six characters are classified as medium and the rest are classified as narrow. Yield characters, correlate strongly with dry harvested cob weight per plant; with cob length correlated moderately; four characters are weakly correlated and other characters are not correlated with yield. Plants selected to form the sixth selfing generation, namely plants that are taller and have narrower leaf angles and flower simultaneously.

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The authors declare no conflict of interest.

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