Selection of several hybrid maize (Zea mays L.) genotypes under low nitrogen condition

A N K Amas, M Y Hardiansyah, Y Musa and A R Amin

Department of Agronomy, Agrotechnology Study Program, Faculty of Agriculture, Hasanuddin University, Makassar, Indonesia

E-mail: azmikarimah08@gmail.com

Abstract. Low soil N nutrient content is a limiting factor in efforts to increase the maize production. Hybrid maize varieties are generally very responsive to fertilization and have high yields in optimal environments in contrast to abiotic stress conditions such as low nitrogen. Therefore, it is necessary to develop hybrid maize with low N tolerance by genotyping at low N fertilization conditions. This research aims to obtain hybrid maize genotypes tolerant to low nitrogen with high production and to determine characters that have high heritability values. The research was carried out in the Experimental Farm of the Cereals Plant Research Institute, Bajeng Subdistrict, Gowa Regency, South Sulawesi Province. The research was arranged in a Split Plot Design with the main plot is dose of nitrogen (0 kg N/ha, 100 kg N/ha, 200 kg N/ha) while subplots were hybrid maize genotypes consisted of 12 genotypes and 3 comparative varieties (Nasa 29, Bisi 18, and Jakarin 1). The results show that the hybrid genotype tolerant to low nitrogen with high production were AVLN 83-2 x AVLN 124-9 genotypes in the treatment without nitrogen fertilization and AVLN 83-2 x AVLN 32-8, AVLN 83-2 x AVLN 124-4, AVLN 83-2 x AVLN 124-9, AVLN 83-2 x AVLN 100-1, AVLN 122-2 x AVLN 124-9, AVLN 122-2 x AVLN 100-1, and AVLN 118-7 x AVLN 124-9 at a nitrogen dose of 100 kg N/ha. Characters with high heritability values were peeled cobs weight, cobs diameter, cobs length, 1000 seeds weight, and productivity.

1. Introduction
Nitrogen (N) is an important nutrient that is needed by maize plants in all growth stages. The use of fertilizers for hybrid seeds that respond to fertilization causes high levels of fertilizer requirements, especially nitrogen (N) fertilizers. Maize requires about 20-30% N fertilizer in its growth phase. N nutrient can be utilized optimally by plants with the lowest possible N loss rate and reduce the negative impact on the environment because not all nitrogen can be absorbed by plants where some of the nitrogen is lost in the form of gas [1]. The N nutrient loss in maize plants through evaporation from 11-48%, denitrification 0.8-1.2% and N₂O emissions of 0.9-1.7% of the N urea dose that given to plants. About 15% of the N fertilizer in maize is leached in the form of nitrate [2]. Low soil N nutrient content is also a limiting factor in efforts to increase maize production. Almost 70% of the maize planted area in Indonesia is found on dry and rainfed land where the main problem on these lands is the low availability of soil N nutrients. Low levels of N are caused by its mobile nature in the soil, easily dissolved and evaporated, washed, and carried away by surface runoff [3].

Hybrid varieties are superior varieties that resulting from plant breeding which are proven to be able to produce 15% better than free-polinated varieties [4]. The productivity increasing through hybrid...
maize can reach 10-13 tonnes/ha. Superior varieties of hybrid maize are generally very responsive to N fertilization because they are selected in optimal N environmental conditions and have low yields in land conditions with abiotic stress such as low nitrogen [5]. The results of research by Efendi et al [6] and Syafruddin [7] stated that to obtain hybrid maize yields of 11-14 tonnes/ha, the N nutrient given to hybrid maize ranged from 180-250 kg N/ha. However, farmers often provide less N fertilizer so resulting in low hybrid maize yields. Selection of several hybrid maize genotypes under low nitrogen conditions can be a strategy for the development of low N tolerant hybrid maize by utilizing less fertile land such as land with a deficiency of N nutrients [8]. The plant character that correlates with yield in low nitrogen conditions can be used as a character for selection of genotypes tolerant to low nitrogen conditions. This research aims to obtain hybrid maize genotypes tolerant to low nitrogen with high production and to determine characters that have high heritability values.

2. Methods
Observations and sample measurements were carried out at the Experimental Farm of the Indonesian Cereals Research Institute, Bajeng District, Gowa Regency from August to November 2019. Data analysis was carried out at the Cereals Plant Research Institute, Maros Regency and at the Plant Breeding Laboratory, Faculty of Agriculture, Hasanuddin University from December 2019 to January 2020.

The research was arranged in a Split Plot Design with 3 levels of nitrogen dose consisted of 0 kg N/ha (n0), 100 kg N/ha (n1), and 200 kg N/ha (n2) as the main plot and sub plot consisted of 12 genotypes of hybrid maize, namely AVLN 83-2 × AVLN 124-9 (g1), AVLN 83-2 × AVLN 32-8 (g2), AVLN 83-2 × AVLN 124-4 (g3), AVLN 78-1 × AVLN 32-8 (g4), AVLN 32-8 × AVLN 114-4 (g5), AVLN 83-2 × AVLN 100-1 (g6), AVLN 122-2 × AVLN 124-9 (g7), AVLN 118-7 × AVLN 100-1 (g8), AVLN 122-2 × AVLN 100-1 (g9), AVLN 118-7 × AVLN 124-9 (g10), AVLN 83-2 × AVLN 78-1 (g11), AVLN 83-2 × AVLN 83-2 (g12), and 3 comparative varieties (Nasa 29, Bisi 18, and Jakarin 1).

2.1 Stages of preparation, planting and maintenance
The seeds used were the seeds of a cross breeding, healthy, have a minimum growth capacity of 80%, and pure physically and genetically. Planting distance used was 70 cm × 20 cm with 2 maize seeds per planting hole. The first fertilization was SP36 167 kg/ha and KCl 100 kg/ha which was given on day 11 with urea fertilizer treatment of 0 kg N/ha, 100 kg N/ha (217.40 kg urea/ha), and 200 kg N/ha (217.40 kg urea/ha). The second fertilization was given on the 34th day only on 200 kg N/ha (n2) treatment with dose 217.40 kg urea/ha. Plant maintenance was carried out includes replacement, weeding, planting, spraying and thinning carried out periodically and optimally.

2.2 Stages of observing plant characters
This stage includes observations for all individual plants. The plant characters observed were stem diameter, peeled cobs weight, cobs diameter, cobs length, 1000 seeds weight, seed yield (%) and productivity (t/ha) calculated by the equation:

\[
\text{Productivity} = \frac{10,000 \ m^2 \times (100 - KA) \times \text{weight of the harvest cobs} \times R}{LP} \times (100 - 15)
\]

LP = harvest area (m²)

The stress tolerant index is calculated based on the seed production proposed by Fernandez [9]:

\[
\text{ITC} = \frac{Y_{pi} \times Y_{si}}{Y_{p}^2}
\]

Note:
\[Y_{si}\] = Genotype seed yield under low nitrogen stress conditions
\[Y_{pi}\] = Genotype seed yield under normal conditions
\[Y_{p}\] = Average of seed yield of all genotypes under normal conditions
The criteria for determining the level of tolerance of plants to low nitrogen stress are if the ITC value is 
≤ 0.5 = sensitive, if 0.5 < ITC < 1.0 = tolerant medium, and if ITC ≥ 1.0 = tolerant.

2.3 Data analysis

The data obtained from the observations were analyzed using Variance Analysis with Microsoft Excel 
according to the Split Plot Design. If it is significant, then further analysis is carried out with the Least 
Significance Difference (LSD0.05). 

Heritability analysis was carried out using the heritability equation according to Syukur et al. [10], 
the heritability value was calculated using the following equation :

\[ h^2 = \frac{\sigma^2_g}{\sigma^2_p} \times 100\% \]  

(3)

Heritability value criteria :

- \( h^2 > 50\% \) = High heritability
- \( 20\% \leq h^2 \leq 50\% \) = Moderate heritability
- \( h^2 < 20\% \) = Low heritability

3. Results and discussion

Responses of maize genotypes to different N level is shown in table 1.

Table 1. Stem diameter (mm), cobs diameter (mm) and cobs length (cm) 12 genotypes of nitrogen 
hybrid maize in nitrogen stress condition.

| Genotypes   | N0 (0) | Stem Diameter | N1 (100) | N2 (200) | Cobs Diameter | Cobs Length |
|-------------|--------|---------------|----------|----------|---------------|-------------|
| g1 (AVLN 83-2 x AVLN 124-9) | 19.48 | 20.36 | 19.85 | 4.477 | 15.97 |
| g2 (AVLN 83-2 x AVLN 32-8) | 21.32 | 21.41 | 22.67 | 4.53 | 15.56 |
| g3 (AVLN 83-2 x AVLN 124-4) | 16.90 | 23.13 | 18.60 | 4.514 | 16.37 |
| g4 (AVLN 78-1 x AVLN 32-8) | 17.88 | 19.30 | 19.16 | 3.908 | 14.54 |
| g5 (AVLN 32-8 x AVLN 114-4) | 20.21 | 16.72 | 19.75 | 4.428 | 14.23 |
| g6 (AVLN 83-2 x AVLN 100-1) | 17.34 | 22.67 | 22.49 | 4.39 | 14.55 |
| g7 (AVLN 122-2 x AVLN 124-9) | 18.92 | 29.10 | 20.62 | 4.582 | 14.93 |
| g8 (AVLN 118-7 x AVLN 100-1) | 17.77 | 21.99 | 20.99 | 4.574 | 13.87 |
| g9 (AVLN 122-2 x AVLN 100-1) | 17.02 | 34.16 | 22.10 | 4.49 | 16.02 |
| g10 (AVLN 118-7 x AVLN 124-9) | 17.77 | 27.03 | 19.14 | 4.64 | 14.11 |
| g11 (AVLN 83-2 x AVLN 78-1) | 16.80 | 17.97 | 21.62 | 4.81 | 15.08 |
| g12 (AVLN 83-2 x AVLN 83-8) | 16.29 | 19.66 | 20.62 | 4.329 | 13.13 |
| g13 (Nasa 29) (a) | 18.41 | 19.99 | 23.91 | 4.25 | 15.76 |
| g14 (Bisi 18) (b) | 18.66 | 18.36 | 19.82 | 4.44 | 15.43 |
| g15 (Jakarim 1) (c) | 18.64 | 16.64 | 20.92 | 4.421 | 15.74 |

Note: The numbers followed by the same letter in columns (a,b,c) are significantly different from the comparative 
varieties Nasa 29 (a), Bisi 18 (b), and Jakarim 1 (c) as well as in rows (x,y,z) means that there is no significant 
difference in the treatment of nitrogen dose in the LSD0.05 test.

Analysis of variance in table 1 shows that the genotypes that gave the best results on stem diameter 
character were shown by genotypes of AVLN 122-2 x AVLN 100-1 (g9) and were significantly different 
from the 3 comparative varieties at dose of nitrogen 100 kg N/ha treatment. The character that have
large stem diameter will provide a greater chance of obtaining high yields in low N stress conditions. Under nitrogen stress conditions, plants would remobilize N from stem to seed organs up to 45% of all N remobilization from maize plant organs [11]. The cobs diameter character showed that the best result were shown by AVLN 118-7 × AVLN 124-9 (g10) with a value of 46.04 mm and significantly different from the 3 comparative varieties, while the cobs length character showed that the best results were genotype AVLN 83-2 × AVLN 124-4 (g3) with a value of 16.37 and significantly different from the comparative varieties Bisi 18. The cobs diameter and cobs length are two mutually influencing characters where the increase in cobs length is directly proportional to the increase in cobs weight. Research results of Permittiani et al [12] showed that the application of tested nitrogen significantly increased the yield of maize where the higher the nitrogen dose given, the longer and heavier the cobs produced. Nitrogen increases the cobs length and the cobs diameter so that the cobs weight will also increase [13].

### Table 2. Peeled cobs weight (kg) and seeds yield 12 genotypes of hybrid maize in nitrogen stress condition.

| Genotypes | Peel Cobs Weight | Seeds Yield |
|------------|------------------|-------------|
|            | N0 (0) | N1 (100) | N2 (200) | N0 (0) | N1 (100) | N2 (200) |
| g1 (AVLN 83-2 x AVLN 124-9) | 5.64<sup>a</sup> | 5.82<sup>y</sup> | 8.31<sup>ab</sup> | 80.73<sup>ac</sup> | 80.58<sup>x</sup> | 81.56<sup>x</sup> |
| g2 (AVLN 83-2 x AVLN 32-8) | 5.16<sup>a</sup> | 7.05<sup>ac</sup> | 7.60<sup>ab</sup> | 78.73<sup>c</sup> | 79.74<sup>x</sup> | 80.18<sup>x</sup> |
| g3 (AVLN 83-2 x AVLN 124-4) | 5.50<sup>a</sup> | 6.11<sup>y</sup> | 8.59<sup>ab</sup> | 78.38<sup>x</sup> | 77.97<sup>x</sup> | 78.48<sup>x</sup> |
| g4 (AVLN 78-1 x AVLN 32-8) | 3.23<sup>x</sup> | 3.57<sup>x</sup> | 4.49<sup>x</sup> | 79.92<sup>c</sup> | 78.95<sup>x</sup> | 83.62<sup>x</sup> |
| g5 (AVLN 32-8 x AVLN 114-4) | 5.33<sup>a</sup> | 5.78<sup>x</sup> | 6.22<sup>x</sup> | 78.86<sup>c</sup> | 76.54<sup>x</sup> | 76.97<sup>x</sup> |
| g6 (AVLN 83-2 x AVLN 100-1) | 4.11<sup>y</sup> | 7.32<sup>ac</sup> | 7.85<sup>x</sup> | 77.81<sup>x</sup> | 81.54<sup>x</sup> | 82.44<sup>x</sup> |
| g7 (AVLN 122-2 x AVLN 124-9) | 4.90<sup>a</sup> | 5.39<sup>y</sup> | 8.87<sup>ab</sup> | 80.37<sup>ac</sup> | 79.31<sup>x</sup> | 81.19<sup>x</sup> |
| g8 (AVLN 118-7 x AVLN 100-1) | 4.73<sup>a</sup> | 5.90<sup>y</sup> | 7.52<sup>x</sup> | 79.57<sup>c</sup> | 79.50<sup>x</sup> | 79.80<sup>x</sup> |
| g9 (AVLN 122-2 x AVLN 100-1) | 5.76<sup>a</sup> | 6.84<sup>x</sup> | 6.84<sup>x</sup> | 76.91<sup>x</sup> | 81.84<sup>x</sup> | 81.21<sup>x</sup> |
| g10 (AVLN 118-7 x AVLN 124-9) | 4.66<sup>j</sup> | 6.92<sup>y</sup> | 8.34<sup>ab</sup> | 77.48<sup>c</sup> | 78.99<sup>x</sup> | 78.86<sup>x</sup> |
| g11 (AVLN 83-2 x AVLN 78-1) | 4.02<sup>x</sup> | 4.21<sup>x</sup> | 4.63<sup>x</sup> | 64.64<sup>y</sup> | 81.32<sup>x</sup> | 81.75<sup>x</sup> |
| g12 (AVLN 83-2 x AVLN 83-8) | 2.97<sup>y</sup> | 5.12<sup>x</sup> | 6.00<sup>x</sup> | 83.68<sup>ac</sup> | 83.27<sup>x</sup> | 84.15<sup>x</sup> |
| g13 (Nasa 29) (a) | 3.43<sup>y</sup> | 5.96<sup>x</sup> | 6.37<sup>x</sup> | 75.16<sup>x</sup> | 79.04<sup>x</sup> | 79.80<sup>x</sup> |
| g14 (Bisi 18) (b) | 5.05<sup>y</sup> | 6.54<sup>x</sup> | 6.57<sup>x</sup> | 80.67<sup>x</sup> | 79.77<sup>x</sup> | 80.77<sup>x</sup> |
| g15 (Jakarin 1) (c) | 4.53<sup>z</sup> | 5.88<sup>y</sup> | 8.18<sup>x</sup> | 73.27<sup>y</sup> | 82.16<sup>x</sup> | 82.25<sup>x</sup> |

Note: The numbers followed by the same letter in columns (a,b,c) are significantly different from the comparative varieties Nasa 29 (a), Bisi 18 (b), and Jakarin 1 (c) as well as in rows (x,y,z) means that there is no significant difference in the treatment of nitrogen dose in the LSD<sub>0.05</sub> test.

Analysis of variance in table 2 shows that the genotype that gave the best results on the peeled cobs weight character was the genotype AVLN 122-2 × AVLN 100-1 (g9) (5.76 kg) and significantly different from the comparative variety Nasa 29 in the treatment without nitrogen fertilizer, genotype AVLN 83-2 × AVLN 100-1 (g6) (7.32 kg) and significantly different from the comparative varieties.
Nasa 29 and Jakarim 1 in the treatment of nitrogen dose 100 kg N/ha, and genotype AVLN 122-2 × AVLN 124-9 (g7) and significantly different from the comparative varieties Nasa 29 and Bisi 18 in the treatment of nitrogen dose 200 kg N/ha. The weight of the peeled cob is one of the characters of the plant that plays an important role in supporting productivity. The weight character of peeled cobs is influenced by nutrient content, one of which is nitrogen. If the supply of N decreases, the plant will move N from leaves to seeds which will affect maize production. Provision of nitrogen in sufficient quantities gives optimal results because the formation of protein in plants to form fruit grains is also maximal [14]. The higher the nitrogen dose within a certain limit when the plants start flowering can spur the growth and formation of seed rows per cob [15]. As for the character of seeds yield, the genotype that gave the best results in the treatment without nitrogen fertilization was shown by the genotype AVLN 83-2 × AVLN 83-8 (g12) (83.68%) and significantly different with the comparative varieties Nasa 29 and Jakarim 1.

Table 3. 1000 seeds weight (g) and productivity (t/ha) 12 genotypes of hybrid maize in nitrogen stress condition.

| Genotypes          | 1000 Seeds Weight | Productivity |
|--------------------|-------------------|--------------|
|                    | N0 (0)            | N1 (100)     | N2 (200)     | N0 (0)   | N1 (100)   | N2 (200)     |
| g1 (AVLN 83-2 x AVLN 124-9) | 29.1 ab           | 28.2 b       | 33.74 ab     | 5.5 ab   | 5.61 y     | 8.27 ab x    |
| g2 (AVLN 83-2 x AVLN 32-8)   | 24.23 y           | 26.36 ab     | 27.99 ab     | 4.8 ab   | 6.52 x     | 7.23 x       |
| g3 (AVLN 83-2 x AVLN 124-4)  | 28.93 y           | 28.23 ab     | 31.31 ab     | 5.1 ab   | 3.8 y      | 5.62 y x     |
| g4 (AVLN 78-1 x AVLN 32-8)   | 22.89 y           | 24.28 y      | 25.71 ab     | 3.09 y   | 3.44 x     | 4.61 x       |
| g5 (AVLN 32-8 x AVLN 114-4)  | 23.84 y           | 23.28 xy     | 27.24 ab     | 4.9 xy   | 5.25 x     | 5.74 x       |
| g6 (AVLN 83-2 x AVLN 100-1)  | 21.57 z           | 25.56 x      | 28.48 x      | 3.81 x   | 7.05 x ab  | 7.65 x ab    |
| g7 (AVLN 122-2 x AVLN 124-9) | 26.27 x           | 28.4 x       | 31.33 x      | 4.7 x    | 5.12 y x   | 8.66 x ab    |
| g8 (AVLN 118-7 x AVLN 100-1) | 25.65 x           | 26.93 x      | 27.76 ab     | 4.4 x    | 5.72 y x   | 7.22 x       |
| g9 (AVLN 122-2 x AVLN 100-1) | 25.35 x           | 25.75 x      | 26.26 ab     | 5.3 x    | 6.68 y x   | 6.67 x       |
| g10 (AVLN 118-7 x AVLN 124-9) | 28.26 y           | 29.08 x ab   | 31.74 x ab   | 4.28 x   | 6.51 x     | 8.00 x ab    |
| g11 (AVLN 83-2 x AVLN 78-1)  | 23.36 y           | 23.83 y      | 29.07 x ab   | 3.14 x   | 4.13 y x   | 4.78 x       |
| g12 (AVLN 83-2 x AVLN 83-8)  | 22.59 y           | 24.07 xy     | 26.23 x      | 2.9 y    | 5.03 y x   | 5.95 x       |
| g13 (Nasa 29) (a)            | 24.73 y           | 26.21 x      | 28.01 x      | 3.00 x   | 5.46 x y   | 5.96 x x     |
| g14 (Bisi 18) (b)            | 24.23 x           | 25.93 x      | 25.97 x      | 4.72 y   | 6.21 x y   | 6.24 x x     |
| g15 (Jakarim 1) (c)          | 28.99 y           | 30.00 xy     | 31.67 x z    | 3.90 x   | 5.85 y z   | 8.08 x x     |

Note: The numbers followed by the same letter in columns (a, b, c) are significantly different from the comparative varieties Nasa 29 (a), Bisi 18 (b), and Jakarim 1 (c) as well as in rows (x, y, z) means that there is no significant difference in the treatment of nitrogen dose in the BNT0.05 test.

Analysis of variance in table 3 shows that the genotype AVLN 83-2 × AVLN 124-9 (g1) gave the best results of 1000 seeds weight and significantly different with the comparative varieties Nasa 29 and Bisi 18 in the treatment without nitrogen and fertilization with a nitrogen dose of 200 kg N/ha with values of 29.18 g and 33.74 g respectively meanwhile in the fertilization treatment with a nitrogen dose 100 kg N/ha, genotype with the best yield of 1000 seeds as shown by the genotype AVLN 118-7 × AVLN 124-9 (g10) with a value of 29.98 g and significantly different with comparative varieties Nasa
29 and Bisi 18. As for the character of productivity, genotype that gave the best results in the treatment without nitrogen fertilization as shown by the genotype AVLN 83-2 × AVLN 124-9 (g1) (5.51 t/ha) and significantly different with the comparative varieties Nasa 29 and Jakarin 1, genotype with the best results in the treatment of a nitrogen dose 100 kg N/ha were shown by the genotype AVLN 83-2 × AVLN 100-1 (g6) (7.05 t/ha) and significantly different with comparative varieties Nasa 29, and genotype with the best results in the treatment of nitrogen dose 200 kg N/ha shown by the genotype AVLN 122-2 × AVLN 124-9 (g7) (8.66 t/ha) and significantly different with the comparative varieties Nasa 29 and Bisi 18.

Stress tolerant index data is a data that calculated based on seed production which consist of the stress tolerant index for the stress tolerant index value can screen tolerant genotypes of hybrid maize with high yield potential under stressful conditions [18].

| Genotypes                | N0  | Note | N1  | Note |
|--------------------------|-----|------|-----|------|
| g1 (AVLN 83-2 x AVLN124-9) | 1.04 | T    | 1.06 | T    |
| g2 (AVLN 83-2 x AVLN 32-8) | 0.79 | MT   | 1.08 | T    |
| g3 (AVLN 83-2 x AVLN 124-4) | 0.93 | MT   | 1.02 | T    |
| g4 (AVLN 78-1 x AVLN 32-8) | 0.32 | S    | 0.36 | S    |
| g5 (AVLN 32-8 x AVLN 114-4) | 0.65 | MT   | 0.69 | MT   |
| g6 (AVLN 83-2 x AVLN100-1) | 0.66 | MT   | 1.23 | T    |
| g7 (AVLN 122-2 x AVLN124-9) | 0.93 | MT   | 1.01 | T    |
| g8 (AVLN 118-7 x AVLN 100-1) | 0.74 | MT   | 0.94 | MT   |
| g9 (AVLN 122-2 x AVLN 100-1) | 0.82 | MT   | 1.03 | T    |
| g10 (AVLN 118-7 x AVLN 124-9) | 0.78 | MT   | 1.19 | T    |
| g11 (AVLN 83-2 x AVLN 78-1) | 0.32 | S    | 0.36 | S    |
| g12 (AVLN 83-2 x AVLN 83-8) | 0.40 | S    | 0.68 | MT   |
| g13 (Nasa 29) (a) | 0.41 | S    | 0.74 | MT   |
| g14 (Bisi 18) (b) | 0.67 | MT   | 0.88 | MT   |
| g15 (Jakarin 1) (c) | 0.72 | MT   | 1.08 | T    |

Notes: The letters in the treatment column nitrogen dose 0 kg N/ha (N0) and nitrogen dose 100 kg N/ha (N1) have symbols (S, MT, T) mean nitrogen sensitive (S) ITC ≤ 0.5, nitrogen medium tolerant (MT) 0.5 < ITC ≤ 1.0, and nitrogen tolerant (T) ITC ≥ 1.0.

The stress tolerant index value in table 4 shows that the genotype AVLN 83-2 × AVLN 124-9 (g1) gave tolerant results to the treatment without nitrogen fertilization, while the genotypes that showed tolerant results to the fertilizer treatment with nitrogen dose 100 kg N/ha shown by genotype AVLN 83-2 × AVLN 124-9 (g1), AVLN 83-2 × AVLN 32-8 (g2), AVLN 83-2 × AVLN 124-4 (g3), AVLN 83-2 × AVLN 100-1 (g6), AVLN 122-2 × AVLN 124-9 (g7), AVLN 122-2 × AVLN 100-1 (g9), and AVLN 118-7 × AVLN 124-9 (g10). As for the genotype AVLN 83-2 × AVLN 100-1 (g6) and AVLN 118-7 × AVLN 124-9 (g10) which gave tolerant results in the fertilizer treatment with a nitrogen dose of 100 kg N/ha had better stress tolerant index values than the comparative variety Jakarin 1.

The greater the stress tolerant index value, the greater the maize genotype productivity was produced under stressful conditions. The use of stress tolerant criteria is used to select prospective hybrid maize varieties to be released to obtain tolerant hybrid maize with high productivity under stress and optimum conditions [16, 17]. The selection of hybrid maize based on the stress tolerant index value can screen tolerant genotypes of hybrid maize with high yield potential under stressful conditions [18].

The heritability prediction value of a character is also very important to know to determine whether the diversity of characters is more influenced by the genetic or environmental factors. The heritability analysis in table 5 shows that there are 5 observed characters that have high heritability values, namely the weight of peeled cobs, cobs diameter, cobs length, 1000 seeds weight, and productivity. The
observed character of stem diameter has a low heritability value (8.06 %) and seed yield character with heritability value 38.82 % which was classified as moderate.

**Table 5.** Heritability analysis of various genotypes of hybrid maize at various nitrogen doses.

| Observational Character | $\sigma^2_{g}$ | $\sigma^2_{p}$ | $h^2$ (%) |
|-------------------------|---------------|---------------|-----------|
| Stem Diameter           | 0.48          | 6.00          | 8.06 (L)  |
| Peel Cobs Weight        | 0.79          | 1.20          | 65.41 (H) |
| Cobs Diameter           | 3.01          | 5.37          | 56.04 (H) |
| Cobs Length             | 0.80          | 1.45          | 54.91 (H) |
| Seeds Yield             | 4.27          | 11.01         | 38.82 (M) |
| 1000 Seed Weight        | 4.62          | 5.92          | 78.10 (H) |
| Productivity            | 0.66          | 1.07          | 61.52 (H) |

Notes: $\sigma^2_g$ genotypic variance, $\sigma^2_p$ phenotypic variance, $h^2$ = heritability, H = High, M = Moderate, L = Low.

The high heritability prediction values indicates that the influence of genetic factors is greater than the influence of environmental factors. Plant characters that have a high heritability prediction value will increase the effectiveness of selection because the observed characters are a reflection of the influence of genetic factors [19]. The higher the heritability value, it means that the diversity of production traits is more influenced by differences in plant genotypes in the population and with little influence on environmental diversity. The higher the heritability value of a selected trait, the higher the increase in the trait obtained after selection [20]. The increased heritability value is due to a decrease in environmental variation or an increase in genetic variability [21].

4. Conclusion
The conclusion of this research is that there is 1 genotype that is tolerant of low nitrogen stress in the treatment without nitrogen fertilization which is genotype AVLN 83-2 $\times$ AVLN 124-9 (g1) while in the fertilization treatment with a nitrogen dose of 100 kg N/ha there are 7 genotypes that are tolerant of low nitrogen stress are genotypes AVLN 83-2 $\times$ AVLN 124-9 (g1), AVLN 83-2 $\times$ AVLN 32-8 (g2), AVLN 83-2 $\times$ AVLN 124-4 (g3), AVLN 83-2 $\times$ AVLN 100-1 (g6), AVLN 122-2 $\times$ AVLN 124-9 (g7), AVLN 122-2 $\times$ AVLN 100-1 (g9), and AVLN 118-7 $\times$ AVLN 124-9 (g10). The characters that have high heritability are shown by the characters of peeled cobs weight, cobs diameter, cobs length, 1000 seed weight, and productivity.

References
[1] Rahim I and Halima T 2013 Pertumbuhan jagung bermutu tinggi pada berbagai dosis nitrogen *Jurnal Galung Tropika* 2 152-158
[2] Cal GX, Chen DL, Ding H, Pacholski A, Fan XH and Zhu ZL 2002 nitrogen losses from fertilizers applied to maize, wheat and rice in The North China Plain *Nutr. Cycling Agroecosyst.* 63 187-195
[3] Sutoro 2012 Kajian penyediaan varietas jagung untuk lahan suboptimum *Jurnal Iptek Tanaman Pangan* 7 82-87
[4] Satimela PS, Mhike X, MacRobert JF and Muungani D 2006. Maize hybrids and open-pollinated varieties: Seed production strategies *Strategies for 27 Strengthening and Scaling Up Community-Based Seed Production* ed Setimela PS and Kosina P (Mexico DF (US): CIMMYT FAO)
[5] Azizah E, Setyawan A, Kadapi M, Yuwiah Y and Ruswand D 2017 Identifikasi morfologi dan agronomi jagung hibrida unpad pada tumpangsar dengan padi hitam di dataran tinggi arjasari Jawa Barat *Jurnal Kultivasi* 16 1-8
[6] Efendi R, Suwardi, Syafruddin and Zubahtirodin 2012 Penentuan takaran pupuk nitrogen pada tanaman jagung hibrida berdasarkan klorofil meter dan bagan warna daun Pertanian Tanaman Pangan 31 27-34

[7] Syafruddin 2015 Manajemen pemupukan nitrogen pada tanaman jagung Jurnal Litbang Pertanian 34 105-116

[8] Farid BDR M, Ridwan I, Nasaruddin, Musa Y, Handayani AR, Amin AR and Widiayani N 2020 IOP Conf. Ser.: Earth Environ. Sci. 575 012110

[9] Fernandez GCJ 1992 Effective selection criteria for assessing stress tolerance Proc. of the International Symposium on Adaptation of Vegetables and Other Food Crops in Temperature and Water Stress ed Kuo CG (Tainan: AVRDC Publication) 257-270

[10] Syukur M, Siani S and Rahmi Y 2015 Teknik Pemuliaan Tanaman (Jakarta: Penebar Swadaya)

[11] Chen Y, Xiao C, Chen X, Li Q, Zhang J, Chen F, Yuan L and Mi G 2014 Characterization of the plant traits contributed to high grain yield and high grain nitrogen concentration maize Field Crops Res. 159 1–9

[12] Permitiani NP, Made U and Adrianton 2018 Pengaruh pemberian berbagai dosis pupuk nitrogen terhadap pertumbuhan dan hasil tanaman jagung manis (Zea mays saccharata) Jurnal Agrotekbis 6 329-335

[13] Nurcahya AO, Ninuk H and Bambang G 2017 Pengaruh macam pupuk organik dan waktu aplikasi terhadap pertumbuhan dan hasil jagung manis (Zea mays saccharata Sturt) Jurnal Produksi Tanaman 5 1-8

[14] Fitriyah N 2019 Respon pertumbuhan dan produksi jagung pulut lokal (Zea mays ceratina L.) pada kondisi cekaman kering dan nitrogen rendah Jurnal Ilmiah Hijau Cendekia 5 1476-1482

[15] Sirajuddin M and Sri AL 2010 Respon pertumbuhan dan hasil jagung manis (Zea mays saccharata) pada berbagai waktu pemberian pupuk nitrogen dan ketebalan mulsa jerami Jurnal Agroland 17 184-191

[16] Efendi R and Muhammad A 2015 Kriteria indeks toleran jagung terhadap cekaman kekeringan dan nitrogen rendah Pros. Seminar Nasional Serealia Balai Penelitian Tanaman Serealia

[17] Farid M, Musa Y, Nasaruddin and Ridwan I 2019 IOP Conf. Ser.: Earth Environ. Sci. 235 012027

[18] Moradi H, Akbari GA, Khorasani SK and Ramshini HA 2012 Evaluation of drought tolerance corn (Zea mays L.) new hybrids with using stress tolerance indices Eur. J. Sustain. Dev. 1 543-559

[19] Basir M 2001 Pemanfaatan nilai heritabilitas dan koefisien korelasi untuk menentukan indikator seleksi Jurnal Agrivigor 1 1-6

[20] Waluyo D and Suharto 2010 Heritabilitas, Korelasi Genotip, dan Sidik Lintas Beberapa Karakter Galur-Galur Kacang Merah (Phaseolus vulgaris L.) Di Dataran Rendah (Surakarta: Universitas Sebelas Maret)

[21] Sutarman LW 2013 Heritabilitas pada Tanaman Kedelai (Glycine max L.) (Bandar Lampung: Universitas Lampung)