Growth and yield responses of three maize varieties toward fertilizing package at dry land in Aceh province

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Abstract. Aceh is one of the centers for hybrid maize production with an area of 47,160 ha and a production of 205,125 tons. Increased production of maize can be achieved by applying technological components, including the use of superior varieties and recommendations for fertilization and spacing to obtain maximum results. The purpose of this study was to determine the response of growth and yield of three high yielding varieties of hybrid maize to the fertilization package. This research was conducted from July to October 2019 in Bireun District, Aceh Province. The research used a randomized block design (RBD) with 3 replications and for each treatment 15 plants were assigned as samples. The first factor is the variety (V), namely V1: Pioneer 32; V2: Bima 19, and V3: Bima 20. The second factor is the fertilizer package (P) which consists of 2 (two) levels: P1 (recommendation) (urea 270 kg / ha, NPK 400 kg / ha, KCl 50 kg / ha); P2 (specific location) (urea 150 kg / ha, SP-36 75 kg / ha, NPK 300 kg / ha). The results showed that the Bima 20 variety with the recommended fertilizer package gave the highest production of 8.03 ton/ha.

1. Introduction
Maize (Zea mays L.) is an important crop because it is rich in dietary fiber that the body needs [1]. In addition to food, it can be used as feed and other industries. The potential for maize productivity in Indonesia can reach 7.0 – 7.5 tons ha⁻¹ but is still far from expectations because, in 2010, maize production was recorded at only 4.43 tons ha⁻¹ [2]. The main obstacle to maize production is the conversion of fertile land for non-agricultural purposes [3]. Maize plants respond very well to high fertility soils. In line with the above statement in terms of soil cultivation, the fertilization aspect must be considered. In fertilization, the accuracy of the dosage, the proper method, and timing of fertilization is essential for optimum production. Fertilizers that are commonly used in sweet maize cultivation are organic fertilizers (natural) and artificial fertilizers (chemical).

Aceh Province is one of the provinces that has extensive dry land, namely ±562,789 ha [2], most of which is a suboptimal dry land with a hilly type that can be used for agricultural land, especially maize. As one of the maize-producing provinces in Indonesia with low maize production compared to other provinces in Indonesia, the area expansion and maize production do not show significant figures. In 2014, maize production in Aceh Tenggara District was 122,331 tons, the harvested area was 28,634 ha with the productivity of 42.72 kw / ha. South Aceh Regency 45,166 tons, harvested area 10,572 ha with a productivity of 42.72 kw / ha. Bireuen Regency 3,584 tons, harvested area 839 ha with productivity of 42.71 kw / ha and Pidie Jaya Regency 572 tons, harvest area 134 ha with the productivity of 42.68 kw / ha [2].
Moreover, to increase maize production in Aceh, it can be done in various ways, including by using high yielding hybrid and composite maize varieties. The spread of new high yielding varieties has been slow so far, this is influenced by environmental conditions that vary from time to time and locations. However, hybrid maize types are very sensitive to the growing environment, while the diversity of their appearance is influenced by differences in genetic makeup. Genetic diversity is a genetic strand that is expressed in a different phase or overall growth which is expressed in various plant traits which include plant form and function which results in a diversity of plant growth [4].

Apart from fertilizing, the use of the right varieties will increase the production of hybrid maize. Variety is one of the many determining factors in plant growth and yield. Apart from environmental factors, the use of high yielding varieties is one of the most important technical components to achieve high production. The use of inorganic fertilizers to increase yields is effective in only a few years, according to consistent use on a long-term basis [5]. Plant growth can be optimal if the nutrients are sufficient. This study aims to determine the response of growth and yield of three high yielding varieties of hybrid corn to fertilization packages.

2. Methodology
This research was conducted in Blang Gandai Village, Jeumpa District, Bireun Regency, Aceh in July - October 2019. Soil analysis of the research location was carried out at the Soil and Plant Laboratory, Institute for Agricultural Technology Assessment, (BPTP) Aceh, Banda Aceh.

The materials used in this study were hybrid corn varieties Bima 19, Bima 20 and Pioneer 32, NPK, Urea, SP-36, and KCl. The research design used a factorial randomized block design (RAK) consisting of hybrid maize varieties (V) as the first factor, namely V1: Pioneer 32; V2: Bima 19 and V3: Bima 20 and the fertilization package (P) as a second factor consisting of 2 (two) levels: P1 (recommendation) (urea 270 kg / ha, NPK 400 kg / ha, KCl 50 kg / ha,); P2 (site-specific) (urea 150 kg / ha, SP-36 75 kg / ha, NPK 300 kg / ha). The combination of the variety factor and the fertilization package resulted in 6 treatments that were repeated 3 times resulting in 18 experimental units with 15 plants as samples per experimental unit.

The observation variables were plant height (cm), cobs weight (grams), the weight of peeled cobs (grams), the weight of 100 grains (grams), the weight of dry shelled seeds (grams), and production/yield (ton ha⁻¹). The results of the observation were analyzed using analysis of variance (ANOVA) at the level of confidence of 95%, if F count is greater than F table then it is followed by Duncan's Multiple Range Test (UJBD) 95%.

3. Results and discussion

3.1. Characteristics agro-ecosystem of the study location
Climate characteristics of the study sites show high rainfall during 2018 [2]. In addition, based on the results of soil analysis containing low nutrients and acid soil conditions at the study location. Climate and soil characteristics of the study site by Figure 1 and Table 1.
Table 1. Soil Chemical Analysis Results in Blang Gandai Village, Jeumpa District, Bireun Regency, Aceh.

| No | Parameter                          | Analysis Results | Criteria     |
|----|------------------------------------|------------------|--------------|
| 1  | Texture                            |                  |              |
|    | - Sand (%)                         | 23.73            | Clay         |
|    | - Dust (%)                         | 24.87            |              |
|    | - Clay (%)                         | 51.80            |              |
| 2  | pH                                 |                  |              |
|    | - H2O                              | 6.00             | Acid         |
| 3  | Organic Materials                  |                  |              |
|    | - C-Organic (%)                    | 2.02             | Low          |
|    | - N total (%)                      | 0.18             | Very Low     |
|    | - C/N                              | 11.10            | Moderate     |
| 4  | Extract HCl 25%                    |                  |              |
|    | - P2O5 (mg 100 g⁻¹)                | 3.61             | Low          |
|    | - K2O (mg 100 g⁻¹)                 | 21.09            | Low          |
| 5  | Olsen (ppm P2O5 100 g⁻¹)           | 1.89             | Low          |
| 6  | K-Morgan (K-dd cmol 100 g⁻¹)       | 6.03             | Low          |
| 7  | KTK (cmol(+)) kg⁻¹                 | -                | -            |

Note: *analyzed at the Soil and Plant Laboratory of Aceh Assessment Institute of Agricultural Technology*

The results of soil analysis show that the nutrient content in the soil existed in the clay texture category, low organic matter and moderate NPK content so that fertilization is needed to increase the availability of nutrients in the soil.

3.2. Analysis results vegetative growth dan yield of maize

The results of the analysis of the variance of various observed variables showed different results on the vegetative and generative variables of various hybrid maize varieties on the tested fertilization packages. In general, the analysis results showed a significant interaction between hybrid maize varieties and the fertilization package. Treatment of varieties and fertilization packages showed a very significant effect on all observed variables. The results of ANOVA analysis of the observed variables are shown in table 2.
Table 2. Results of ANOVA analysis on various observation variables for hybrid maize varieties on fertilization packages

| Variable                  | Treatment                                                                 | Level of Trust |
|---------------------------|---------------------------------------------------------------------------|----------------|
| Plant Height              | **                         | **             | *              |
| Cob + husk                | **                         | **             | **            |
| Cob Without husk          | **                         | **             | **            |
| Dry Shelled Seeds         | **                         | **             | *              |
| 1000 Grains               | **                         | **             | ns            |
| Result                    | **                         | **             | *              |

Note: ns = not significant effect, * = significant effect (0.05), ** = Very significant effect (0.01)

3.3. Plant height
Vegetative growth is very important for the development of the generative phase. Optimal vegetative growth will encourage optimal generative growth so that high yields will be obtained. Observation of plant height is one of the main parameters to determine the degree of adaptation of a variety to an agroecosystem.

Table 3. The average response of plant height at harvest to the treatment of hybrid maize varieties to the fertilizer package.

| Variable                  | Treatment                                                                 |
|---------------------------|---------------------------------------------------------------------------|
|                           | $P_1V_1$ | $P_1V_2$ | $P_1V_3$ | $P_2V_1$ | $P_2V_2$ | $P_2V_3$ |
| Plant Height              | 198.77 b | 201.37 ab | 204.07 a | 169.73 e | 177.83 d | 182.67 c |

Note: The numbers followed by the same letter on the same line show no significant difference (LSD 0.05).

The results of the analysis of variance showed that the treatment of hybrid maize varieties on the fertilization package had a very significant effect on the observation of plant height at harvest. The treatment of Bima 20 ($V_3$) variety in the recommended fertilization package ($P_1$) showed the best height which was significantly different from the Pioner variety ($V_1$) in the recommended fertilization package ($P_1$) and the location-specific fertilization package ($P_2$) and Bima 19 ($V_2$) variety in the package. fertilization recommendation ($P_1$) and specific fertilization packages ($P_2$). The different height of maize is influenced by the ability of each variety to absorb nutrients in the early stages of the growth phase and is also influenced by different genetic factors and adaptability to the growing environment [6].

Adding an NPK fertilizer dose of 400 kg ha$^{-1}$ can increase plant height [7]. A research states that an additional dose of 200-500 kg of ha$^{-1}$ NPK fertilizer can increase plant height until the final phase of vegetative growth [8]. N is a component associated with high photosynthetic activity, strong vegetative growth, and dark green leaves [9].

3.4. Weight of cob with husk and cob without husk (gram)
The results of variance on the observation of cob weighted cob showed a significant difference between treatments where the highest was found in the recommended fertilization package treatment with Bima 20 variety (421.77 gr) but not different from the recommended fertilization package treatment with Pioner 32 variety, while the lowest was found in treatment specific fertilization location with Pioner 32 variety (259.23 gr). Whereas in the observation of cob without husk weight showed a significant difference between treatments where the highest was found in the package treatment Fertilization recommendations with Pioner 32 variety (412.20 gr) but not different from the
recommended fertilization package treatment with Bima 20 variety, while the lowest was found in the specific fertilizer location treatment with Pioner 32 variety (274.80 gr).

**Table 4.** Weight of average cob with husk and cob without husk k in the treatment of hybrid maize varieties on the fertilization package.

| Variable                                | Treatment         |
|-----------------------------------------|-------------------|
|                                         | P₁V₁  | P₁V₂  | P₁V₃  | P₂V₁  | P₂V₂  | P₂V₃  |
| cob with husk (gram)                    | 420.33 | 404.30 | 421.77 | 259.23 | 281.20 | 284.47 |
| cob without husk (gram)                 | 412.20 | 363.83 | 409.00 | 274.80 | 275.13 | 286.10 |

Note: The numbers followed by the same letter on the same line show no significant difference (LSD 0.05).

The difference in weight of cob with husk and cob without husk between treatments was strongly influenced by genetic factors of each variety such as leaf shape, number of leaves, and leaf length or width which affected the absorption of plant nutrients for the process of plant photosynthesis. Photosynthesis will increase if the absorption of sunlight energy takes place optimally, so that seed production in corn will also increase and its weight increases. This is consistent with Susilowati [10], where the yield of maize is determined by the fresh weight of cobs per plant. The higher the ear weight per plant, the higher the yield will be. Meanwhile, the availability of sufficient nutrients during growth causes the plant's metabolic activity to be more active so that the process of elongation and cell differentiation will be better which in turn can encourage an increase in fruit weight [11].

3.5. Weight of dry shelled seeds (grams) and weight of 100 grains (grams)

The weight of dry shelled seeds and the weight of 100 grains were the observation variables for the yield components in maize.

**Table 5.** Average weight of dry shelled seeds in the treatment of hybrid maize varieties on the fertilizer package.

| Variable                                | Treatment         |
|-----------------------------------------|-------------------|
|                                         | P₁V₁  | P₁V₂  | P₁V₃  | P₂V₁  | P₂V₂  | P₂V₃  |
| dry shelled seeds weight (gram)         | 144.43 | 162.93 | 175.33 | 143.20 | 148.33 | 158.17 |

Note: The numbers followed by the same letter on the same line show no significant difference (LSD 0.05).

The results of variance on the observation of dry shelled weight showed a significant difference between treatments, where the highest was found in the recommended fertilization package treatment with Bima 20 variety (175.33 gr), while the lowest was found in the treatment specific fertilizer package location with Pioner 32 variety (143.20 gr). The weight of dry shelled seeds is related to the amount of photosynthate translocation into the seeds. Rahmi [12] states that the increase in seed dry weight is related to the amount of photosynthate translocation into the seeds and the better the plant root system is able to absorb nutrients from the soil. A sufficiently large translocation of photosynthate to the reproductive organs causes the cob formation and seed filling to take place properly and the seeds to form with a larger size. The high weight of dry shelled seeds indicates that the filling process is optimal. Ukonze et al [13] stated that the high ear weight results might be due to the number of seeds in each ear being measured.

The results of the analysis of the weight variance of 100 seeds (Table 6) showed that the independent treatment of fertilization packages on various hybrid maize varieties and the independent treatment of varieties had a significant effect on the weight of 100 hybrid maize seeds. The highest average weight of 100 seeds in the highest independent fertilization package treatment was found in the recommended fertilization package, namely 33.13 grams, while varieties affected the weight of 100 seeds, where Bima 20 (V₃) variety had the highest average weight of 100 seeds, which was 33.38 grams. varieties of Pioner 32 (V₁) and Bima 19 (V₃).
The difference in weight of 100 grains is closely related to the characteristics of each variety which is related to its ability to absorb nutrients during its growth period. The increase in the weight of 100 grains is also related to the amount of photosynthate translocation into the seeds and the better the plant root system is able to absorb nutrients from the soil. The large enough translocation of photosynthate to the reproductive organs causes the cob formation and seed filling to take place properly and the seeds are formed with a larger size so that they affect the weight of 100 grains.

3.6. Production/Yield (tons ha⁻¹)

The results of analysis of variance showed that the treatment of three hybrid maize varieties on the fertilization package had a significant effect on crop production. P1V3 treatment was significantly different from treatment P1V1, P1V2, P2V1, P2V2 and P2V3. Treatment P1V3 had the highest yield, namely 8.03 tons ha⁻¹ which was significantly different from other treatments.

Table 6. Average weight of 100 grains (grams) in the treatment of hybrid maize varieties on the fertilization package

| Variable          | Fertilization Package | Variety     |
|-------------------|-----------------------|-------------|
|                   | P1 | P2 | V1 | V2 | V3 |
| 100 grains        | 33.13 a | 31.57 b | 31.60 b | 32.07 b | 33.38 a |

Note: The numbers followed by the same letter on the same line show no significant difference (LSD 0.05)

Plant production is closely related to the availability of nutrients related to the seed filling process [14]. The absorbed nutrients will be accumulated into the leaves to form the proteins that form the seeds. The accumulation of metabolic products in the formation of seeds will increase so that the seeds that are formed have the maximum size and weight, this happens when the nutrient needs are met which causes the metabolism to run optimally. In line with another research Seriminawati et al [15] which states that good growth is supported by sufficient nutrient absorption resulting in the resulting photosynthate being increased and stored in the storage network so that it affects the development and growth of plant parts which in turn will significantly increase the yield of maize.

4. Conclusion

Based on the research results, it can be concluded that the varieties and fertilization packages have a significant effect on the growth and yield of hybrid maize. Bima 20 variety combined with the recommended fertilizer package gave better results compared to other varieties, namely 8.03 tons ha⁻¹.

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