Evaluation of hybrid corn genotype on productivity improvement to support national food availability

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Abstract. Potential lines need to be tested to produce new superior varieties of hybrids with high yield potential to increase corn productivity. The purpose of the research is to produce a single cross-strain has the appearance of a good agronomist, double cob and high yield potential, as a candidate release of varieties. The study began in April to July 2018. Experimental site in the Lembar village, West Lombok Regency, West Nusa Tenggara Province. Eight crosses of a single cross-tested all showed the appearance of a good agronomist, in accordance with the criteria of belonging to four varieties comparison (Bisi-2, Nasa-29, HJ-21 and Bima-3). There is one the crosses cross-E2 x Mr14 was good combiner for double ear with the percentage exceeded 28% per ha. There are four single cross-E 2 X Mr 14, E 1 X Mr 14, E 65 X Mr 14, MS 3 X Mr 14, which has a high yield potential with the weight of the dried seeds > 13 ton/ha. There are four potential lines that can be released as a new high yielding varieties.

1. Introduction
Food is a basic need for people to be able to maintain life. Therefore, the adequacy of food for every person at all times is a human right that deserves to be fulfilled. Based on this fact, the problem of fulfilling food needs for all residents at any time in a region is the main target of food policy for a country’s government [1].

In Indonesia, corn is one of the foods that has the potential to be developed as local food [2]. While based on the order of the world’s basic food ingredients, corn ranks third after wheat and rice. Besides being a food ingredient, corn is also used for feed and industrial raw materials. National maize needs in each year increased significantly along with population growth [3].

Corn occupies an important position in the economy as well as national food security because of its extensive use as a source of food, animal feed and industrial raw materials. Its extensive use and high demand for corn make this plant one of the four strategic food commodities in addition to rice, soybeans, and cassava which receive special attention from the ASEAN economic community (MEA) [4].

Although corn production in Indonesia is the highest compared to other ASEAN countries which reached 18.5 million tons in 2013, national maize needs reached 20.8 million tons [5]. Thus, efforts to
improve national corn productivity in an integrated and sustainable manner are a necessity so that food security and national food sovereignty can be achieved.

Efforts to increase corn productivity, one of which can be done by providing varieties of corn varieties that have high yield potential, namely hybrid varieties. Hybrid varieties have high yield potential, 15-20% higher than free-range varieties in addition to providing a high uniformity of agronomic appearance and early harvesting age [6]. Hybrid varieties also show better plant performance in stressed environmental conditions, including acid soils [7], [8]; [9]. Superior hybrids are not only determined by the appearance of parent inbred lines, but are also determined by the ability to join in inbred lines crossed to produce hybrids [4].

This study aims to evaluate several genotypes of single-cross hybrid maize to obtain hybrids that have good agronomic appearance, have the potential for double ear and have high yield. It is expected that from the various hybrids evaluated, new hybrid candidates will be obtained with higher yields than commercial hybrids.

2. Materials and Methods
The research was conducted in Lembar Village, Lembar District, West Lombok Regency, West Nusa Tenggara from April to July 2018. Research Sites in rice field agroecosystems, which are at an altitude of 30 m above sea level, with latosol soil types.

Plant materials used in the study were 12 hybrid corn genotypes consisting of 8 single cross lines ((E65 X Mr14, G688 X Mr14, E2 X Mr14, E1 X Mr14, Mr14 X N51, G682 X Mr14, G649 x Mr14, MS3 X Mr14)) and 4 comparison varieties (Bisi 2, NASA 29, Bima 3 and HJ 21). The four varieties are high yielding potential hybrid maize, specifically for Bisi-2 and Nasa-29 varieties used as a comparison of two-pronged varieties. Other materials used are Urea fertilizer, NPK Phonska fertilizer, manure, herbicide, insecticide and fungicide. The tools used include: hoes, tools, meters, calipers, scales, moisture meters, cameras and other tools that support this research.

This study used a Randomized Block Design of 12 hybrid hopes and four comparable hybrid varieties, each of which was repeated three times, so that there were 36 experimental units. Each experimental unit consists of four rows of plants (3 m wide) with a length of 5 meters.

Corn plants are planted with a spacing of 75 cm x 20 cm, with a seed system of 1 seed per planting hole. Planting holes are closed again with 250 g (1 hand) of manure per planting hole. Fertilization is carried out 2 times at the age of 10 days and 35 days, with a dose of fertilizer used as much as 300 kg of NPK Phosnka / Ha and 250 kg Urea / Ha. Fertilization is done manually, then fertilizer is closed again with soil. Weeding is carried out at the age of 21 days, using a selective herbicide. For pest control, when planting each hole Carbofuran 3G is given at a rate of 16 kg / ha, and given again at the age of plants 3-4 times if there is a pest attack. Watering is done every 2 weeks or according to the conditions of the plants and harvesting is done when physiological cooking plants.

Data collected in this study include; agronomic data (plant height, cob position height, age of male flower exit, age of female flower discharge, number of crops, number of harvesting cobs), yield and yield components (ear length, ear diameter, number of rows / ear, number of seeds / row dried seed yield). Data were analyzed using Analysis of variance (ANOVA), if there were differences between treatments, then a further test was carried out using Duncan at the 5% level.

3. Results and Discussion

3.1. Plant Agronomy
From the results of the analysis in Table 1, it is known that genotypes have a significant effect on plant height. Where the single cross hybrid genotype (G649 x Mr14) has the highest plant that is 251.83 cm, which is not different from the plant height in single cross genotypes E65 X Mr14 (238.83 cm) and comparable varieties Bisi-2 (243.83 cm). While the lowest plants were the single cross hybrid genotype G 682 X Mr14 (208.00 cm) which was no different from the other 5 genotypes and from the comparable varieties of Bima-3. This shows that all single cross hybrid genotypes tested had criteria
that were in accordance with the released hybrid corn varieties. The difference in plant height between hybrid genotypes is caused by genetic factors and environmental factors. Plant height shows the potential of each of the hybrid genotypes tested. According to Syukur [10], that the higher the plant, the greater the number of leaves that increase the efficiency of photosynthesis. Sari [11], also stated that high maize plants have more leaves, these plants have the potential to be used as a source of animal feed, because good animal feed sources are plants that have good vegetative growth. Crops are higher, tends to get more sunlight intensity, so the leaves will absorb more light to be used for photosynthesis. So that the resulting assimilation is high, which affects the increased dry material of plants including seeds [12].

The height of the cob from the analysis results is influenced by the genotypes of the plants tested. The single cross genotype of G 649 x Mr 14 has the highest cob position height of 132.53 cm, which is not significantly different from the location of the hybrid genotype E 65 X Mr 14 and 3 comparable varieties Bisi-2 (133.80 cm), Nasa-29 and HJ-21. While the lowest cob position is in the hybrid genotype G 682 X Mr 14 (103.73 cm) which is not different from the cob height in the other 5 hybrid genotypes of 1 comparable variety Bima-3 (109.93 cm). This means that all hybrid genotypes tested have the same criteria as the comparison varieties that have been released. According to Siswati [13], that cob height is one of the guidelines for the implementation of selection. According to Moedjiono et al. [14], that the level of corn crop breeding has a relationship with plant height and cob height, where tall plants tend to fall more easily than with short plants. According to Syukur [10] that in maize breeding, the low position of the main cob is the desired character, this is because the low cob location will be easier to accept pollen because physiologically is less blocked by leaves. The position of the cob that is balanced in the middle of the plant will be better.

Age out of male flowers is also influenced by the genotypes tested. Where the single cross hybrid genotype G682 X Mr14 has a longer male outflow age of 54 days that is not significantly different from the other 4 single cross hybrid genotypes in sequence Mr14 X N51, E65 X Mr14, G688 X Mr14, MS3 X Mr14 (52.00 -53.67 days) and 3 comparative varieties sequentially, namely Nasa-29, HJ-21, Bisi-2 (51.33-53.67 days), but significantly different from the 3 other single cross hybrid genotypes, E2 X Mr14, G649 x Mr14, E1 X Mr14 and 2 comparison varieties Bisi-2 and Bima-3 (51.67 - 52.67 days). The difference occurs because it is influenced by genetic factors. Single cross hybrid genotypes that are not significantly different from Bima-3 comparable varieties have a faster harvesting age than other genotypes. For single cross hybrid genotypes that are not significantly different from Bima-3, they will tend to be more early maturing or faster to harvest.

For the age of the exit the female flower is also affected by the genotype tested. Of the 8 hybrid genotypes tested, there were 5 single cross hybrid genotypes and 2 comparative varieties (Nasa-29 and HJ-21) which had a longer lifespan of female flowers of 53.67 - 55.33 days, which was significantly different from 3 hybrid genotypes other single crosses namely E2 X Mr14, G649 x Mr14, E1 X Mr14 and 2 comparison varieties Bisi-2 and Bima-3 (51.67 - 52.67 days). The difference occurs because it is influenced by genetic factors. Single cross hybrid genotypes that are not significantly different from Bima-3 comparable varieties have a faster harvesting age than other genotypes. This result is consistent with Singgah [15], that male flowering and female flowers have a significant effect on the tested hybrid genotype. Of the 47 lines tested, they have a shorter age compared to the comparable varieties of Pertiwi 3, so that the 47 lines will be faster than Pertiwi varieties 3. The sooner the plants begin to flower, the plants will be able to be harvested and produce results faster. The compatibility between the age of female flowering and male flowering age is very important because this is related to fertilization, Siswati [13]. This has been explained by Jones and Kiniry in Yasin [16] that synchronization of panicle formation in male and female plants guarantees the optimal fertilization process.

Anthesis Shilking Interval (ASI) is the time difference between the discharge of male and female flowers. The smaller the value of breast milk, the repair process takes place well. From the results of the analysis in table 1 on the value of ASI, it is known that 8 single cross hybrid genotypes and 4 comparable varieties tested had low ASI values. This shows that the occurrence of pollination synchronization between male and female flowers, which will have a positive effect on the filling and seed formation process. According to Nursehang [17], the smaller the Diversity Coefficient (KK), the
more male and female flowering time is, the more pollination faster and faster harvesting, so the potential for better yields. The length of the ASI period is strongly influenced by environmental conditions. Short breast milk is important to ensure synchronization of flowering period in corn plants. Therefore the ability of plants to produce short milk on acidic land during the reproductive phase is one of the criteria for selecting plants that produce high on acid soils.

Table 1. Agronomic Performance in 12 hybrid corn genotypes tested in Lembar Village, Lembar District, West Lombok Regency in dry season the 2018.

| Genotype                  | Plant height (cm) | Ear height (cm) | Day to Tasseling (day) | Day to Silking (day) | Anthesis Silking Interval (ASI) |
|---------------------------|-------------------|-----------------|------------------------|----------------------|--------------------------------|
| E 65 X Mr 14              | 238.83 abc        | 130.80 a        | 53.67 ab               | 55.00 ab             | 1.33 ab                        |
| G 688 X Mr 14             | 212.92 ef         | 117.87 bc       | 52.33 abc              | 53.67 abcd           | 1.33 ab                        |
| E 2 X Mr 14               | 213.50 ef         | 112.27 cde      | 51.00 bc               | 52.67 bcd            | 1.67 ab                        |
| E 1 X Mr 14               | 217.08 def        | 117.73 bcd      | 50.33 c                | 51.67 d              | 1.33 ab                        |
| Mr 14 X N 51              | 213.33 ef         | 109.27 d        | 53.67 ab               | 54.67 abc            | 1.00 b                         |
| G 682 X Mr 14             | 208.00 f          | 103.73 d        | 54.00 a                | 55.33 a              | 1.33 ab                        |
| G 649 x Mr 14             | 251.83 a          | 132.53 a        | 51.00 bc               | 52.67 bcd            | 1.67 ab                        |
| MS 3 X Mr 14              | 221.92 edf        | 115.73 bcede    | 52.00 abc              | 53.00 abcd           | 1.00 b                         |
| Bisi 2                    | 243.83 ab         | 133.80 a        | 51.33 abc              | 52.33 cd             | 1.00 b                         |
| Nasa                      | 231.42 bcd        | 125.07 ab       | 53.67 ab               | 55.33 a              | 1.67 ab                        |
| HJ 21                     | 225.67 cde        | 123.53 abc      | 52.00 abc              | 54.33 abc            | 2.33 a                         |
| Bima 3                    | 212.50 ef         | 109.93 de       | 50.67 c                | 52.33 cd             | 1.67 ab                        |

Remarks: Numbers followed by the same letters in the same column, show no significant difference at the level of 5%.

3.2. Yield Components

From the results of the analysis in Table 2, it is known that the length of the cob is influenced by the genotype tested. From the 8 genotypes tested there were 3 single cross hybrid genotypes which had the longest cob sequentially, namely G682 X Mr14, E2 X Mr14, E65 X Mr14 with length 18, 20 - 19.43 cm which is significantly different from 5 other single cross lines and 4 comparison varieties. This indicates that the 3 single cross lines above have the potential and opportunity to be a source of new hybrid superior varieties, because they have a longer cob compared to the released varieties. Where the ear length is one component that affects the dry shell weight of corn kernels. According to Siswati [12], that the factors that influence the difference in ear length of contents on each strain can be influenced by genetic factors of each parent of the cross.

The ear diameter is also significantly affected by the genotype. Of the 8 hybrid genotypes tested, there are 5 single cross hybrid genotypes that have larger cob diameters in sequence, namely MS3 X Mr 14, E65 X Mr14, E2 X Mr14, E1 X Mr14, Mr14 X N51, with diameter (4.66 - 4.99 mm), which is not significantly different from the comparative varieties of Bisi-2 and Bima-3. Even though the five single cross strains mentioned above have not been able to exceed the ear diameter of the comparative varieties of HJ-21 (5.39 mm) but have been able to match 2 comparable varieties, namely Bisi-2 and Bima-3. From these results indicate that the five single cross lines mentioned above have entered the variety criteria. Explained by Mimbar [18], the relationship between the length of the cob, the diameter of the ear with the weight of the cob is increased by the length of the cob and the diameter of the cob. The character of the cob diameter can affect the weight of the cob produced.

The number of lines per ear is also influenced by the genotype. Of the 8 strains tested there were 3 single cross hybrid genotypes sequentially having more number of rows per ear, G 649 x Mr 14, E 1 X Mr 14, Mr 14 XN 51, with number of rows (14-27-15.47) , which was not significantly different from the comparison variety HJ-21 (14.67 lines), but was significantly different from the 5 other single cross hybrid genotypes from 3 comparable varieties Bisi-2, Nasa-29 and Bima-3.
Table 2. Components of results and results in 12 genotypes that were tested in Lembar Village, Lembar District, West Lombok Regency in the 2018 Dry Season.

| Genotype                  | Cob length (cm) | Cob diameter (mm) | Number of lines per cob (line) | Number of seeds per line (seed) | weight of 1000 seeds (g) | dry seed weight (t/ha) |
|---------------------------|-----------------|-------------------|--------------------------------|---------------------------------|--------------------------|------------------------|
| E 65 X Mr 14             | 19.43 a         | 4.77 bc           | 13.07 cde                      | 38.40 a                         | 447.90 a                  | 13.86 a                |
| G 688 X Mr 14            | 17.07 cd        | 4.59 c            | 12.67 e                        | 35.53 abc                       | 376.57 a                  | 11.45 bc               |
| E 2 X Mr 14              | 18.57 ab        | 4.88 bc           | 13.33 bcde                     | 34.07 cd                        | 387.57 a                  | 13.29 a                |
| E 1 X Mr 14              | 17.20 bcd       | 4.88 bc           | 14.40 abc                      | 32.00 d                         | 489.67 a                  | 13.64 a                |
| Mr 14 X N 51             | 17.73 bcd       | 4.99 b            | 14.27 abcd                     | 34.73 bcd                       | 479.37 a                  | 12.61 ab               |
| G 682 X Mr 14            | 18.20 abc       | 4.92 bc           | 13.60 bcde                     | 37.40 ab                        | 449.97 a                  | 12.35 abc              |
| G 649 x Mr 14            | 16.93 cd        | 4.59 c            | 15.47 a                        | 33.80 cd                        | 384.57 a                  | 10.91 c                |
| MS 3 X Mr 14             | 16.73 cd        | 4.69 bc           | 12.93 de                       | 36.00 abc                       | 435.33 a                  | 13.87 a                |
| Bisi 2                   | 17.63 bcd       | 4.74 bc           | 12.93 de                       | 38.33 a                         | 434.00 a                  | 13.00 ab               |
| Nasa                     | 17.30 bcd       | 4.60 c            | 13.73 bcde                     | 35.47 abc                       | 402.63 a                  | 12.27 abc              |
| HJ 21                    | 17.03 cd        | 5.39 a            | 14.67 ab                       | 34.27 bcd                       | 452.97 a                  | 12.53 abc              |
| Bima 3                   | 16.53 d         | 4.91 bc           | 13.87 bcde                     | 35.00 bcd                       | 439.27 a                  | 12.23 abc              |

Remarks: Numbers followed by the same letters in the same column, show no significant difference at the level of 5%.

For the number of seeds per row, the results of the analysis are also influenced by the genotype. There are 4 single cross lines that have more number of seeds per row in sequence, G688 X Mr14, G 682 X Mr 14, E 65 X Mr 14, with the number of seeds (35,53 -38,40 seeds ) which were not significantly different from the comparison varieties Nasa-29 and Bisi-2, but were significantly different from 4 other single cross lines and 2 comparative varieties of HJ-21 and Bima-3. According to PPPTP [19], that of the tested female parent lines has good potential to be chosen as elders for the manufacture of hybrid varieties. This is based on the characteristics of the number of lines per ear on several superior hybrid corn varieties, namely 12-16 lines such as BIMA 14-BATARA, BIMA 13-Q, PAC 759 and JK-8.

The weight of 1000 seeds is used to determine the number of seeds needed per unit of land area. If the size of the seeds is large then the number of seeds needed per unit area is more than the small seeds. In physiology of plants, seeds that have a larger size have better growing power compared to small ones. From the results of the analysis it was found that the weight of 1000 seeds in the 8 single cross hybrid genotypes tested and 4 comparison varieties were not significantly different. This shows that the 8 single cross hybrid genotypes tested have potential and opportunities to be tested further or released into new varieties, because they are in accordance with the criteria of the varieties that have been released.

3.3. Double Ear

Eight lines tested are lines that have high yield potential and have the chance to double collide. Comparative varieties that have the potential of double ear are Bisi-2 and Nasa-29. From the results of the analysis of the number of crops and the number of harvested cobs obtained lines that have the potential to produce double ear. From Figure 1 shows that the single cross hybrid genotype E2 X Mr14 has the highest percentage of double ear, which is 28%, which is significantly different from 7 other single cross hybrid genotypes and 4 comparable varieties. For single cross hybrid genotypes and varieties that have negative values in the figure show that the number of harvesting cobs is less than the number of crops. This means that there are some corn plants that do not produce cob or can produce cob but filling the seeds is not perfect. From these results indicate that the E2 X Mr14 single cross hybrid genotype has the chance to be released into new hybrid superior varieties.
Figure 1. Percentage of double ear in 12 genotypes tested in Lembar Village, Lembar Subdistrict, West Lombok district in the 2018 dry season.

Figure 2. Dry seed weight in 12 genotypes tested in Lembar Village, Lembar District, West Lombok Regency in the dry season of 2018.

3.4. Dry seed weight
From Figure 2 it is known that genotype influences the weight of dried seeds. Of the 8 hybrid genotypes tested, there were 4 single cross hybrid genotypes with the potential to weigh more than 13 tons of dry seed, sequentially ie E 2 X Mr 14, E 1 X Mr 14, E 65 X Mr 14, MS 3 X Mr 14, exceed 4 comparison varieties. This shows that the four single cross hybrid genotypes above have the chance to...
be released into new hybrid superior varieties, because the potential yield exceeds the varieties that have been released. According to Maintang et al. [20], that the higher the weight of dry seeds obtained means the higher the rate of accumulation of dry matter distributed during the process of filling seeds. Seeds are formed through the process of pollination and fertilization. Early pollination will prolong the process of filling the seeds so that it allows the seeds to accumulate more dry matter into the seeds.

4. Conclusion
A single cross-hybrid genotype that generates higher productivity than all the comparative varieties is (MS 3 X Mr 14) 13.87 t/ha, (E 65 X Mr 14) 13.86 t/ha, (E 1 X Mr 14) 13.64 t/ha, and (E 2 X Mr 14) 13.29 t/ha. Thus the four hybrids can be proposed to become new superior varieties. There is one single cross-hybrid genotyping that has better double-cob potency than all the comparative varieties i.e. E2 X Mr14. This hybrid has a double-copulsed potential with a percentage of 28% per ha. Thereby, this hybrid can be continued to multi-site test by exploring its excellence so that it can be removed into comparative varieties.

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Reference
[1] Suryana, A. 2005. Kebijakan Ketahanan Pangan Nasional. Pusat Penelitian dan Pengembangan Pertanian Kementerian Pertanian. Jakarta.
[2] Kamsiati E. dan Purwandari, S. 2006. Diversifikasi Pengolahan Jagung dalam Rangka Meningkatkan Ketahanan Pangan di Kalimantan Tengah. Balai Pengembangan Teknologi Pertanian. Kalimantan Tengah.
[3] Hermanto. 2008. Asian Regional Maize Workshop: Sumber Inovasi Teknologi Jagung. Warta Penelitian dan Pengembangan Pertanian, Pusat Penelitian dan Pengembangan Tanaman Pangan. 30 (6): 1-6. Bogor.
[4] Hayati PKD, Sutoyo, T B Prasetyo. 2016. Penampilan jagung hibrida silang tunggal dari berbagai kombinasi perilangan galur inbrida. Prosiding Seminar Nasional Masyarakat Biodiversiti Indonesia. 2 (2): 162-168.
[5] Indonesia Investments. 2015. Corn production and consumption in Indonesia: Aiming for self-sufficiency. www.indonesiainvestments.com. com. 10 April 2016.
[6] Duvick D N. 1999. Commercial strategies for exploitation of heterosis. In: Coors JG, Pandey S (eds). The Genetics and Exploitation of Heterosisin Crops. ASA, CSS and SSSA Inc. Madison, Wisconsin.
[7] Hayati PKD, A Syarif, T B Prasetyo. 2014a. Evaluasi hibrida dan kemampuan daya gabung beberapa galur inbred jagung di lahan masam. Jurnal Agroteknologi 4(2): 39-43.
[8] Hayati PKD, Sutoyo, A Syarif. 2014b. Performance of maize single-cross hybrids evaluated on acidic soils. Int J Adv Sci Eng Inf Technol 4(3): 31-33.
[9] Hayati PKD, Saleh G, Shamshuddin J. 2015. Breeding of maize for acid soil tolerance: Heterosis, combining ability and prediction of hybrid based on SSR markers. Scholar’s Press, Omni Scriptum GmbH and Co., Saarbrucken, Germany.
[10] Syukur, M. Siani S., Rahmi Y., dan Khaerin N., 2011. Pendugaan Komponen ragam, Heritabilitas dan Korelasi untuk menentukan Kriteri seleksi cabai (Capsicum annuum L.). Populasi F5.J.Hortikultura Indonesia 1(3):74-80.
[11] Sari, H.P. 2013. Uji daya hasil 12 hibrida harapan jagung manis (Zea mays var.saccharata) di Kabupaten Maros, Sulawesi Selatan. J. Agrohorti 1(1):14-22.
[12] Aribawa, I. B., I.K. Kariada, & M. Nazam. 2006. Uji Adaptasi Beberapa Varietas Jagung di Lahan Sawah. Balai Penelitian Teknologi Pertanian Bali.
[13] Siswati A, N Basuki dan A N Sugiharto 2015. Karakterisasi Beberapa Galur Inbrida Jagung Pakan (Zea mays L.) Jurnal Produksi Tanaman, 3(1): 19 – 26.
[14] Moedjiono dan M J Mejaya. 1994. Variabilitas Genetik Beberapa Karakter Plasma Nutfah Jagung Koleksi Balitbang Malang. Jurnal Zuraiat 5(2): 27 – 32.
[15] Singgah M I, R B Ainurrasjid, A N Sugiharto. 2017. Uji Potensi Hasil galur harapan Hasil Persilangan Topcross pada Tanaman Jagung. Jurnal Produksi Tanaman. 5(5):717-724.
[16] Yasin, M. 2013. Penangkaran Benih Jagung Hibrda Silang Tiga Jalur Di Pelaihari, Kalimantan Selatan. Seminar Nasional Sereal. Balai Pengkajian Teknologi Pertanian Kalimantan Selatan.
[17] Nursehang, R Agus, E Tambaru, M Azrai., 2013. Variabilitas Genetik Hasil Persilangan Diallel pada Jagung Pulu Hibrda Zea mays L. Universitas Hasanuddin Sulawesi Selatan. Makasar.
[18] Mimbar, S M. 1990. Pola Pertumbuhan dan Hasil Jagung Kretek karena Pengaruh Pupuk N. Agrivita.13(3): 82-89.
[19] Pusat Penelitian dan Pengembangan Tanaman Pangan. 2013. Deskripsi Varietas Unggul Jagung. Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian.
[20] Maintang dan M Nurdin. 2013. Pengaruh Waktu Penyerbukan terhadap Keberhasilan Pembuahan Jagung pada Populasi Satp-2 (s2) c6. Balai Pengkajian Teknologi Pertanian Sulawesi Selatan. Agrilan (Jurnal Agribisnis Kepulauan). (2):94-108.