Evaluation of Potential Production of Maize Genotypes of Early Maturity in Rainfed Lowland

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Abstract**—**Maize development at the rainfed lowland after rice is often confronted with the occurrence of drought stress at the time of entering the generative phase, which will cause be hampered crop production. Consequently, in the utilization of the rainfed lowland areas optimally, an effort that can be done using the varieties of early maturity to minimize crop failures due to its short rainy season. The aim of this research was evaluating the potential yield of genotypes of candidates of maize early maturity in the rainfed lowland areas. The study was conducted during May to August 2016 at South Sulawesi, Indonesia. The study used randomized block design to compare 12 treatments and consists of 8 genotypes namely CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8 and the use of four varieties, namely Bima 3, Bima 7, Lamuru and Gumarang. The results showed that genotype of CH2, CH3, CH5, CH 6, CH7 and CH8 harvesting has less than 90 days. There are two genotypes namely genotypes of CH7 and CH8 that have a fairly high production respectively of 7.16 tons / ha and 8.11 tons/ ha and significantly not different from the superior varieties Bima3.

Keywords**—**Evaluation, maize, early maturity, yield potential.

I. Introduction

MAIZE is one of the main food commodities that are in the trade of agricultural products, nationally and internationally. The demand for corn from year to year is increasing in line with rising raw material needs of industrial food, feed and biofuel as a renewable fuel that is an alternative energy. This is reflected in the high demand for of maize from some importing countries such as India and China. Besides, the United States and Australia, as the largest maize producer in the world, is currently unable to meet the needs of their domestic of maize [1]. This condition is an opportunity for the export of maize.

In Indonesia, of maize is a source of major raw materials industries poultry feed and forage quality (80 t / ha - 100 t / ha), a primary food for some communities in East Indonesia, and as the second largest contributor after rice in the gross domestic product [2]. Consequently, an increase on maize production in the country should be keep to be pursued.

Efforts to increase production of maize has been implemented either through intensification and extensification program. Extensification program at the rainfed lowland areas by planting of maize after the rice is often faced with the problem of drought stress at flowering and seed filling phase. The occurrence of drought stress at the stadium this will lead to delays in in the harvest and grain quality is low [3], [4] and can cause a decrease in seed weight and number of seeds up to 30% [5], [6]. Hence, the development of maize need effort to cope with drought problem in marginal dryland. One effort that can be done to reduce the adverse effects of drought on crop production of maize is the development of crop varieties that are early maturity.

Development of the early maturity varieties of maize (80 days - 90 days) and super early maturity (70-80 days) is an effort to minimize crop failures due to its short period of rain which is the impact of climate change [7]. However, varieties early maturity existing generally in the form of local varieties and composites such as local the Ciamis, Kodok, Pool-2, Florida Plint synt the yield potential is still low. The last few years have been released varieties of early maturity with a potential yield slightly higher than the open pollinated the maize varieties that have been exist such Gumarang, Krishna, and Palakka (mean ± 5 ton / ha), so it should also be made of the hybrid varieties with a yield potential of ± 5-7 t / ha. At the end of 2010 was released two single cross hybrid the maize varieties by age 89 ± 7 days and the Bima 7 and Bima 8 [8]. Until now the early maturity hybrid maize produced breeders still lacking, therefore the research aimed to evaluate the results of several prospective hybrid of the maize genotypes early maturity at the rainfed lowland areas.

II. Materials and Methods

This study is a field experiment was conducted at the rainfed lowland areas in Gowa South Sulawesi, Indonesia from May to August 2016. Materials used include: of hybrid maize seed candidates, from 8 genotype namely: CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8 and the use of four (4) varieties namely Bima 3, Bima 7, Lamuru and Gumarang. Population composer/base population of genetic material derived from CIMMYT Mexico from early maturity group. The study was designed as a randomized block design consisting of 12 treatments, CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8 and the four (4) varieties i.e.: Bima 3, Bima 7, Lamuru and Gumarang. Each treatment was repeated three times as a group, in order to obtain 36 units of the experiment.

Tillage the land by plowing the soil, destruction of the aggregates and rotary ground to further refine the texture of the soil. Land is divided into 3 blocks as a group, then each block is divided into 12 plots size of 3 m x 2.7 m. Planting maize was done 1 with a spacing of 50 cm x 30 cm with planting two seeds per hole. Irrigation was given every 10 days (depending on weather conditions). Organic and

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inorganic fertilizers were applied to the plots. At the time of planting, Furadan 3 G was applied with a dose of 8 kg/ha. The first fertilization given at 7 days after planting using NPK Phonska 15:15:15 with a dose of 350 kg/ha and urea with a dose of 150 kg/ ha. Second fertilization performed at 30 days after planting by urea with a dose of 250 kg/ha and NPK Phonska 15:15:15 with a dose of 100 kg/ha. Weeding was done 2 times that is two (2) and 4 weeks after planting (WAP) as well as tthinning at two weeks after planting. Harvest is done when the plant enters phase of physiological maturity is characterized by formation of black layer on the seed. The variables were observed i.e. plant height, LAI, anthesis, and silking period, time of harvesting, cob length, cob diameter, cob weight, grain weight per cob, 1000 kernels weight, dry grain yield per ha. All collected data were subjected to analysis of variance and LSD (Least Significant Difference) tests were done to determine differences between treatment means [19].

III. Results and Discussion

Plant Height and Leaf Area Index (LAI)

The results of data analysis maize plant height and LAI at 8 WAP indicate that there were differences in genotype significant effect on plant height and LAI (leaf area index) value. LSD test results are presented in Table I indicate that genotype CH7 and CH 8 resulted in higher plants (275.53 cm and 270.80 cm) and significantly different varieties Bima 3, 7 and Gumarang Bima. The genotypes tested had LAI values are large enough that the above 3 (4.32-4.91) and generally significantly different Gumarang varieties which are varieties of open pollinated and beumur group of early maturity.

Time Anthesis, Silking and Harvesting

Observations of the anthesis and silking in Table II show that the genotype differences lead to differences in time of anthesis and silking. Anthesis of genotype CH2 and CH5 flowering faster is 45.33 days and significantly different from varieties Bima 3. While the timing of the silking showed that genotype CH2 and CH5 faster flowering respectively on the day to 46.67 and day 47 and significantly different Bima 3 and Bima 7 varieties. The same thing happens at harvesting time indicates that there were three genotypes (CH2, CH5 and CH6) which have a comparatively rapid harvest takes place between 82.33 days - 83.33 days and significantly different from varieties of Bima 3 and Lamuru, but not significantly different from Bima 7 and Gumarang varieties.

The Cob Length, Cob Diameter and Cob Weight

The cob length measurement results in Table III show that there were several genotypes that have cob length of more than 16 cm are of CH1, CH2, CH4, CH6 and CH7 and significantly longer than the varieties used. While CH2, CH6 and CH7 genotype have wider cob diameter (3.83 cm - 3.99 cm) and not significantly different four varieties are used. Table III also shows that there were two genotypes have the cobs weight, which is significantly heavier than varieties Gumarang namely genotype of CH2 and CH6 with cob weight respectively 173.20 g and 174.60 g.

TABLE I
Plant Height and Leaf Area Index (LAI) for Some Maize Genotypes

Maize Genotypes	*Plant Height (cm)*	*LAI*
CH1	266.27 abd	4,84 d
CH2	203.00 abc	4,73 d
CH3	263.53 abd	4,78 d
CH4	252.07 d	4,67 d
CH5	220.20 abc	4,91 d
CH6	240.00 d	4,39
CH7	275.53 abd	4,55 d
CH8	270.80 abd	4,32
Varieties in Comparison		
Bima 3	241.67	4,82
Bima 7	247.13	4,40
Lamuru	258.13	4,44
Gumarang	218.67	3,88
LSD 0.05	***18.92***	***0.56***

Description: number followed by small letters in the same column: a: a: significant different with var Bima3; b: significantly different with var Bima 7; c: significantly different with var Lamuru and d: significantly different with var. Gumarang based LSD 0.05.

TABLE II
Anthesis Period, Silking Period and Harvesting for Some of Maize Genotypes

Maize Genotypes	*Days to Anthesis*	*Days to Silking*	*Days to Harvesting*
CH1	49.00 bcd	51.00 abcd	92.00 abcd
CH2	45.33 a	46.67 abc	82.33 ac
CH3	48.00 cd	50.00 cd	84.67 ac
CH4	49.33abcd	51.00 abcd	92.33 abcd
CH5	45.33 a	47.00 ab	83.33 ac
CH6	47.00 d	49.00 d	83.00 ac
CH7	48.33 cd	50.00 cd	85.00 bd
CH8	47.00 d	48.67 d	87.00 bd
Varieties in Comparison			
Bima 3	47.67	49.33	87.33
Bima 7	46.67	48.67	82.33
Lamuru	46.33	48.33	87.33
Gumarang	45.00	46.33	82.33
LSD 0.05	***1.53***	***1.65***	***2.39***

Description: number followed by small letters in the same column: a: a: significant different with var Bima3; b: significantly different with var Bima 7; c: significantly different with var Lamuru and d: significantly different with var. Gumarang based LSD 0.05.

TABLE III
The Cob Length, Cob Diameter, Cob Weight from Several Maize Genotypes

Maize Genotypes	*Cob Length (cm)*	*Cob Diameter (cm)*	*Cob Weigt (g)*
CH1	16.96 abcd	3.51 abc	144.60 c
CH2	16.13 abd	3.85	173.20 d
CH3	14.14 c	3.57 abc	133.93 ac
CH4	16.53 abd	3.49 abc	140.13 ac
CH5	15.89 bd	3.72 ac	154.53
CH6	16.21 abd	3.99	174.60 d
CH7	16.09 bd	3.83	166.00
CH8	14.78 b	3.71 ac	149.20
Varieties in Comparison			
Bima 3	14.89	3.99	166.80
Bima 7	13.44	3.93	156.60
Lamuru	15.56	3.96	169.00
Gumarang	14.33	3.69	148.80
LSD	***1.38***	***0.23***	***23.05***

Description: Number followed by small letters in the same column: a: a: significant different with var Bima3; b: significantly different with var Bima 7; c: significantly different with var Lamuru and d: significantly different with var. Gumarang based LSD 0.05.

The Kernel Weight per Cob, the Weight of 1000 Kernel and Dry Grain Yield

The results of the analysis of the kernel weight per cob in Table IV show that the genotype of CH2 and CH6 have kernel dry weight per cob heavier than varieties Gumarang with respectively 138.56 g and 139.68 g. However, there is no real difference of genotypes were tested from a variety-comparison on the weight of 1000 seeds. Weight of 1000 seeds obtained from this study ranged 245.00 g - 316.33 g. The variable of dry grain yield per hectare there were 5 genotypes i.e. CH2, CH5, CH6, CH7 and CH8 that have a fairly high production (7.1 ton / ha - 8.4 ton / ha) and did not significant differ with varieties Bima 3, Bima 7 and Lamuru.

IV. Discussion

The results of the analysis of the variable component of growth and production (Tables I-IV) show that there are significant differences of genotypes from varieties tested. Genotype of CH7 and CH8 produce a maize crop were higher (275.53 cm and 270.80 cm). Meanwhile, genotypes tested showed an influence on the value of LAI. This is consistent with [9] which argued that there are differences in LAI values for each type of maize crop. Further proposed by [10] that in order to obtain high yields, the plant should produce LAI enough to absorb most of the light in order to achieve maximum production. From observations also show that the value of the genotypes tested LAI large enough (>4). The value of LAI showed that genotype-genotype tested has the potential for high production, because with these conditions, the photosynthesis of plants is increasing, because the leaves are organs of plants that contribute to the life of the plant, because the leaves of the ongoing process of photosynthesis [11]. Differences in leaf size to some extent will affect the number of results of assimilation formed as deposits of reserves for the growth and yield.

TABLE IV
KERNEL WEIGHT PER COB WEIGHT OF 1000 KERNEL AND DRY GRAIN YIELD PER HA

Maize Genotypes	*Kernel Weight per Cob (g)*	*Weight of 1000 Kernel (g)*	*Dry Grain Yield per ha (t/ha)*
CH1	115.68 c	245.00	6.285 acd
CH2	138.56 d	302.33	5.928 ad
CH3	107.15 ac	262.00	5.693 ad
CH4	112.11 ac	258.33	6.287 acd 6.767 acd
CH5	123.63	281.67	6.240 acd
CH6	139.68 d	294.00	7.162 bcd
CH7	132.80	316.33	8.111 bcd
CH8	119.36	286.33	
Varieties in Comparison			
Bima 3	133.44	282.67	7.863
Bima 7	125.28	282.00	5.960
Lamuru	135.20	276.67	5.131
Gumarang	119.04	250.33	4.491
LSD 0.05	***18.64***	***ns***	***0.99***

Description: number followed by small letters in the same column: a: a: significant different with var Bima3; b: significantly different with var Bima 7; c: significantly different with var Lamuru and d: significantly different with var. Gumarang based LSD 0.05 ns = not significant.

Anthesis and silking period of time were presented in Table II indicate a significant difference between of genotypes tested from varieties. There were because each genotype has a period of vegetative growth was different, so a period of anthesis and silking were also different, and this also affected to the harvest age. Table II can be seen that there were three genotypes namely of CH2, CH5 and CH6 were flowering faster (days to anthesis between 45.33 and 47 days and days to silking between 46.67 and 49 days) and also faster harvesting time was between 82.33 and 83.33 days. Garba and Namo [12] concludes that growth in the old maturing is higher, while early maturing maize is faster flowering. Bello et al. [13], which evaluate the old, medium and early maturing maize on optimal rainfall conditions, suggested that the varieties of early maturing is faster flowering which allows for development in areas experiencing drought stress over a long period.

Observation of the components of yield and production of corn showed that genotype differences significantly affect components and corn production. According to [14], an increase in production of corn cannot be separated from genetic improvement and engineering management. In the dry seed weight parameters of maize per hectare obtained results indicate that genotype CH2 and CH6 has the highest production and significantly higher than the varieties Gumarang. This is supported by long-cob and cob diameter at the verietas CH2 and CH6 is longer and wider (Table III). If the length of the cob average of a variety is longer than the other varieties, the varieties are likely to lead to higher production [15], [16]. Cob cob length and diameter are an important component in the production of corn plants [17]. Fruit consists of maize cob and grains. Grains of maize are arranged in a line attached in a straight or winding on a cob of corn, so the cob length and diameter width will allow space laying of the seeds are also larger, which in turn will produce a heavier weighting cob.

Based on the analysis of harvesting in Table II and the production of dry seed per hectare in Table IV, the genotypes of CH2 and CH6 to be developed as a hybrid varieties early maturing. Both of these genotypes have a range of harvesting that is 82 to 85 days and also have a high enough grain production. Azrai et al. [18] states that in order to support IP 400 program (Index of production 400) of corn, early maturing hybrid maize is a variety of the most prospective to be developed.

V. Conclusion

1. Genotype of CH7 and CH8 have the appearance of plants in the highest, while the value of LAI in general all genotypes tested has a value large enough LAI is > 4
2. Genotype of CH2, CH3, CH5, CH6, CH7 and CH8 have a lifespan of harvest between 82 days - 85 days.
3. Genotype CH7 and CH8 have enough production high at 7.16 tons / ha and 8.11 tons/ha and not significant with hybrid varieties Bima 3.

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