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Agronomic pěrformance and yield potential of 18 corn varieties in Indonesia

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Abstract

Corn is an important crop in Indonesia, yet the national average production is still relatively low (4.5 t ha^{-1}). The objective of this study were (1) to evaluate agronomic performance of 18 Indonesia corn varieties and (2) to compare yield potential of these varieties. This research was conducted at the IPB UF Cikabayan Experimental Station, Darmaga, Bogor. A single-factor randomized complete block design with two replications was used, with an experimental unit size of two 4-m rows plot. Fourteen phenotypic traits, including eight agronomic characters and six yield-related traits were observed. Analyses of variance were performed to elaborate genotype effects on these traits at 0.05 and 0.1 levels, followed by the Duncan Multiple Range Test if the effects are significant. Additionally, cluster analyses based on phenotypic traits were performed to elucidate genetic distances and groups among the genotypes. . The results showed that the agronomic performance and yield potential of these genotypes are not different at 0.05 level; however, the genotypic effects on germination rate, ear height, ear weight per plot, and grain yield per plot, tend to differ at 0.10 level. Two groups of genotypes were shown from the result of clustering, yet apparently the distances between genotypes were small (< 10%). These results provide insight and opportunity to develop improved corn varieties through plant breeding, combining conventional selection methods and advance biotechnological tools.

Keywords: corn breeding, agronomic performance, yield potential, phenotypic variation, cluster analysis

I. INTRODUCTION

Corn in Indonesia is considered as one of the most important food crops, utilized for both human consumption and animal feed. The food balance sheets data from the central Bureau of Statistics (CBS) showed that in 1998, about 69% of corn in Indonesia were used for direct food and manufactured food [1]. Corn production based on the 2012 CBS data was 19.39 million ton, increased about 1.74 million ton (9.88%) from the previous year. The production increase in Java island was 1.24 million ton and in non-Java island was 0.50 million ton. Corn production in 2013 is estimated 18.84 million ton of grain, or a decline of 0.55 million ton (2.83 %) than in 2012. The decline in production is thought to occur because the harvested area decreases 66.62 thousand hectares.. Productivity of corn in Indonesia is still comparably low, around 4.5 t ha^{-1} in 2011. These facts highlight the importance of developing improved maize varieties in Indonesia having high yield potential and adapted to unfavorable environments through plant breeding and biotechnology approaches [2].

Hybrid corn varieties have been shown to provide better results than open pollinated corn varieties. It was stated, that hybrid varieties producing more uniform, 15-20% higher [3] and size of seed was bigger [4] form open pollinated varieties. The objectives of this study were to evaluate agronomic performance of 18 Indonesia corn varieties and to compare yield potential of these varieties.

II.MATERIAL AND METHOD

Experimental Design

This experiment was conducted from May to October 2013 at the IPB UF Experimental Station, Darmaga, Bogor. Eighteen corn varieties grown in Indonesia, namely Bima super, Bionix 09, Bisi-18, Bisi-2, Bisi-222, Bisi-816, DK 77, DK 85, DK 95, DK 979, NK 33, NK 6326, P21, P27, P31, P4, Pertiwi-2 and Pertiwi-3 were evaluated in a randomized complete block design with two replications. Plot size was a two 4-m rows. Seed was planted with a planting distance of 75 cm x 25 cm. Agronomic traits evaluated includes germination rate (GR), plant height, ear height, day to tasseling, day to silking, percentage of standibility, ear aspect, grain color and yield-related characters observed were cornhusk weight, number of ear, ear weight, ear length, ear diameter, grain yield per plot.

Statistical Analysis

Analysis of variance, mean comparison and dendogram based on similarity distance was computed by IRRI - STAR (Statistical Tools for Agricultural Research) and R [5] software. Duncan range test was used to analyze significant different in genotype collection.

III.RESULT AND DISCUSSION

Genotypic Effects

The results of this study generally indicated that the corn genotype evaluated showed small variations for agronomic performance, yield, and components of yield. A summary of analyses of variance for all traits evaluated was given in Table 1.

Table 1. Summary of analysis of variance for agronomic and yield traits observed

Variable	Genotype MS*
Agronomic Performance	
Germination rate	156.73*
Plant height	694.77NS
Ear height	210.59*
Day to tasseling	1.88NS
Day to silking	9.07NS
Percentage of standability	204.64NS
Ear aspect	0.18NS
Grain color	0.26NS
Yield and Component of Yield	
Cornhusk weight	1.08NS
Number of ear	24.95NS
Ear weight	0.60*
Ear length	4.51NS
Ear diameter	0.20NS
Grain yield per plot	202 816.70*

MS: mean square.

* P-value < 0.1; NS = not significant

Analysis of variance showed that germination rate, ear height, ear weight and grain yield per plot tended to differ among genotypes (P < 0.1), yet they were not significant at 0.05 level. The genotypic effects on days to tasseling, days to silking, cornhusk weight, number of ear, ear height, ear diameter, percentage of standability, ear aspect and grain color were not significantly different.

Agronomic Performance

Germination rate of 18 maize genotypes in Table 2 indicated that maize genotypes P21 showed the highest germination rate (88.28%), whereas P4 was the lowest (57.04%). Genotypes with ability to grow better is expected to produce higher yields.

Table 2. Genotype means of germination rate

Genotype	GR (%)*
BIMA SUPER	71.09abcd
BIONIX 09	57.81d
BISI 18	80.47abc
BISI 2	77.34abc
BISI 222	70.31bcd
BISI 816	64.84cd
DK 77	83.59ab
DK 85	75.78abc
DK 95	72.66abcd
DK 979	82.81ab
NK 33	64.06cd
NK 6326	80.47abc
P21	88.28a
P27	81.25abc
P31	77.34abc
P4	57.03d
PERTIWI 2	80.47abc
PERTIWI 3	75.78abc

GR=Germination rate

* Means followed by the same letter were not significantly different based on the DMRT test at α = 0.1.

BISI 2 genotype had the highest ear position (85.3 cm), while the DK 979 had the lowest (57.8 cm) (Table 3). Genotypes with lower ear position are generally desirable because they tend to be more adapted to lodging.

Table 3. Genotype mean of plant height and ear height

Genotype	EH (cm)*	PH (cm)
BIMA SUPER	63.10bcdef	123.0
BIONIX 09	59.75cdef	129.9
BISI 18	73.80abcd	150.7
BISI 2	85.25a	154.2
BISI 222	64.30 bcdef	141.9
BISI 816	60.65cdef	137.5
DK 77	68.60abcde	152.7
DK 85	75.10abcd	162.3
DK 95	72.80abcd	159.9
DK 979	57.80def	125.1
NK 33	48.70ef	121.2
NK 6326	64.60bcdef	158.2
P21	79.70abc	163.2
P27	81.15ab	172.0
P31	72.30abcd	175.3
P4	47.60f	111.6
PERTIWI 2	66.10abcdef	159.9
PERTIWI 3	66.50abcde	153.6

PH=Plant height, EH=Ear height

* Means followed by the same letter were not significantly different based on the DMRT test at □ = 0.1.

Yield and Component of Yield

Genotype means for yield and its components are shown in Table 4 Ear weight showed significantly different result on genotype.

Tabel 4 Genotype means of yield and its components

Genotype	CW (kg)	NE	EW (kg)	EL (cm)	ED (cm)
BIMA SUPER	2.8	20.5	2.20 bcde	15.1	4.1
BIONIX 09	2.6	19.0	1.90 cde	15.8	4.1
BISI 18	2.9	21.5	2.10 bcde	14.7	4.1
BISI 2	3.6	26.5	3.03 ab	16.6	3.7
BISI 222	1.6	14.5	1.42 e	11.6	3.9
BISI 816	3.1	18.0	2.58 bcd	15.1	4.4
DK 77	3.2	20.5	2.38 bcde	17.6	4.1
DK 85	2.5	20.0	1.95 cde	13.7	3.9
DK 95	3.4	25.5	2.42 bcde	13.9	3.9
DK 979	2.6	22.5	2.40 bcde	12.9	3.7
NK 33	2.1	19.5	1.75 de	14.2	4.1
NK 6326	4.9	22.0	3.77 a	16.7	4.7
P21	3.7	21.5	2.80 abcd	15.6	4.6
P27	3.8	28.0	2.50 bcd	15.2	4.2
P31	3.8	23.0	2.95 abc	15.7	4.4
P4	2.9	25.0	2.03 bcde	14.4	4.0
PERTIWI 2	2.5	15.5	1.98 bcde	14.2	4.8
PERTIWI 3	2.7	20.0	2.00 bcde	12.7	4.1

*Means followed by the same letter were not significantly different in Duncan multiple range test at □ = 0.1;

CW= Cornhusk weight; NE= Number of ear; EW= Ear weight; EL= Ear length; ED=Ear diameter.

Genotype NK6326 had the largest cornhusk value (4.9 kg), and BISI-222 had the lowest (1.6 kg). High cornhusk weight does not necessarily reflect to large number of ear. The results showed that the genotype having the largest number of ear was P27 (28), while the smallest was Pertiwi-2 (15.5).

NK6326 genotype showed the highest value of ear weight (3.77 kg). . When converted into production in ton ha^{-1}, the production of hybrid corn genotypes in this study still fairly low, ranged between 2-4 t ha^{-1}. This was because some of the plants were manually crossed and selfed to produce seeds for other studies, and therefore not all ear can be perfectly filled with grain. Considering this fact, it was expected that the values of yield and its components were not optimal.

The similarity distance between 18 genotype divided into two major group (Fig 1.) was small (<10%). First cluster included genotype: BISI-222, NK33, P4, BISI-18, DK85, DK95, P31, pertiwi-3, Pertiwi-2, Bima super, bionix 09, BISI-816, and DK77. Second cluster included NK6326, DK979, P21, BISI-2 and P27.

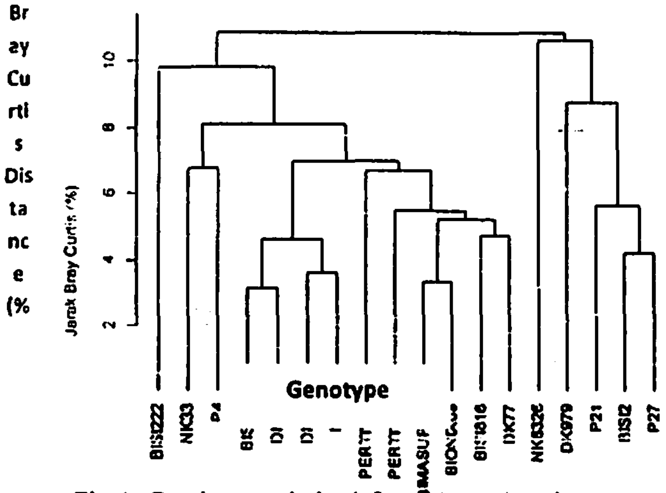

Fig 1. Dendogram derived from cluster based on genotype

The Elucidation of genetic variability was important to decide breeding option for high yield potential. Genotypic variability also can be used for breeding in terms of resistance to drought and salinity.

CONCLUSION

In this experiment, the genotypic effects on two agronomic traits (germination rate and ear height), and two yield-related trait (ear weight per plot and grain yield per plot), tended to differ at 0.10 level. Two groups of genotypes were shown from the result of clustering, yet apparently the distances between genotypes were small (< 10%). In this experiment, agronomic performance resulted to significantly different for germination rate and ear height. Germination rate of 18 corn genotypes showed that maize genotype P21 had the highest value of germination rate (88.28%). Low germination rate was indicated by genotypes P4 (57.04%). BISI-2 had the tallest ear height (85.3 cm), while the lowest was DK 979 genotype (57.80 cm). NK6326 genotype showed the highest value of ear weight (3.77 kg), whereas BISI-222 produced the lowest ear weight (1.42 kg).

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