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The Tolerance of Several Hybrid Corn (Zea mays L.) Varieties Type on Cob Rot in the Plateau of Simalungun Regency

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Abstract
The research was carried out in Dolog Masagal Sub district, Simalungun Regency, altitude ± 1.100 m above sea level. The research was conducted from January to May 2019. The purpose of this study was to determine the tolerance level of several hybrid corn varieties to cob rot disease.

Methods for conducting the research used randomized block design (RBD) with 1 factor. Types of hybrid corn varieties tested were: Pioneer 29 (V1), NK 99 (V2), Pioneer 12 (V3), NK 22 (V4), Pioneer 4 (V5), Nusantara I (V6), Asia 1 (V7). The parameters observed were: plant height, cob diameter, cob length containing seeds, number of seed rows per cob, number of seeds per row, number of seeds per cob, husk cover in cob, cob rot intensity, the amount of dry production per plot, and the weight of 1.000 seeds.

Based on the research results, different types of hybrid corn varieties produce different tolerances of cob rot resistance in the Simalungun highlands. The most tolerant variety of cob rot disease is Pioneer 29 (mild damage scale = 0 - 10%). Different types of varieties planted also affect various components of growth and production, among others: plant height, number of seeds per row, number of seed rows per cob, husk cover on cob, dry production per plot, and weight of 100 grains. As for the parameters of cob diameter, cob length containing seeds and the number of seed rows per cob, the difference in varieties did not significantly affect.

Keywords: hybrid corn, cob rot.

Introduction

The need for corn (*Zea mays* L.) in Indonesia is currently quite large, which is more than 10 million tons of dry shelled annually (Dirjen Tanaman Pangan, 2015).The biggest need for corn is for food and animal feed industry. Corn is an important food ingredient because it is the second source of carbohydrates after rice.As one source of food, corn is a commodity that needs to be developed. The need for animal feed industry also encourages the increasing demand for corn.This can be seen from the growing development of the domestic animal feed industry. For animal feed mixes, corn is needed in large quantities. Approximately 51% of the animal feed mixture consists of corn flour (http: // balitsereal. Litbang. Deptan.go.id, 2009).

As a cereal crop, corn can grow in almost all regions in Indonesia, from the lowlands to the highlands. The area of corn plantations in Indonesia in 2008 reached 4.001.724 hectares with production reaching 16.317.252 tons.In Sumatra Utara corn area in 2008 reached 240.413 hectares, producing 1.098.969 tons of production (http: // database. Deptan.go.id, 2009).

The Sumatera Utara Provincial Agriculture Service (2016) noted that the average Sumatra Utara corn production was 50.13 quintals per hectare. When compared with the potential for superior seed production which can reach 10 tons of dry shelled per hectare, the production of corn in Sumatera Utara and also nationally is still relatively low.The low production of corn in Indonesia, according to Suprapto (2002), was partly due to the narrow use of superior varieties and farming methods that do not meet the recommendations. Busra, Bahri, and Zaini (1997) added that crop management which was not optimal and the presence of plant pests also affected corn productivity.

In order to increase yields per unit area, the use of superior varieties is very prominent. Each variety has different genetic potential. This results in each variety having different characteristics in their growth and ability to produce. Ideal superior varieties are high yielding, resistant to pests, and stable when planted in various environmental targets (Patta Sija and Syafruddin, 2010).

In Indonesia, the expansion of cornfield is done in diverse agroecosystems. Corn is widely planted in a fertile land environment with high productivity and marginal land with low productivity. With the variety of agroecological targets for corn development, genetic improvements are also being made to overcome environmental stress. Hence, for dry land, the improvement of superior varieties is directed at high yielding corn varieties, tolerant of pests and disease resistant to biotic and abiotic stress (Kasim, 2002).

Plant-disturbing organisms such as pests and diseases also greatly affect the yield of corn. For example, cob rot causes a decrease in the quantity and quality of production per unit area of the cornfield. Cob rot disease in maize is thought to be caused by fungal pathogens.This pathogen generally proliferates due to the influence of high humidity, especially if rainfall is high enough (http: //balitsereal.litbang.deptan.go.id, 2009).The facts showed that the tolerance of each corn varieties is different on cob rot disease. In the same place, season, environment and technical culture conditions, some varieties are relatively tolerant and conversely, there are more sensitive varieties.

In order to find out the types of corn varieties that are tolerant to cob rot disease and the performance of each variety planted in the highlands of Simalungun Regency, a field test was conducted in the rainy season cropping.

Research Implementation

The research was conducted in Dolog Masagal Subdistrict, Simalungun Regency. The research area is a dry land with an altitude of ± 1.150 meters above sea level, average annual rainfall of 1.747 mm, with a maximum temperature of 35^0C and a minimum of 20^0C. Climate type "D" (moderate), the average number of rainy days is 189 days/year. The research activities were carried out from January to May 2019.

The method used was randomized block design with 1 factor. The treatments tested were comparing growth and production performance also the tolerance to cob rot disease of seven corn varieties: Pioneer 29 (V1), NK 99 (V2), Pioneer 12 (V3), NK 22 (V4), Pioneer 4 (V5), Nusantara I (V6), Asia 1 (V7).The determination of variety types tested was based on the most planted variety types by farmers in the highlands of Simalungun Regency. Each treatment was repeated 3 times hence there were 24 treatment plots. The treatment plot size was 3.75 m x 2.50 m. The spacing used is 75 cm x 25 cm, each row has 5 rows, and each row has 10 plants.Hence, 50 plants were obtained for each treatment plot. In order to minimize crossing between varieties, between the treatment plots a plastic sheet was installed as insulation. The distance between treatment plots was set at 300 cm and the distance between replications was 400 cm.

Observational data were analyzed statistically. Statistical analysis was performed using a mathematical model (Gomes, 1995):$Yij = \mu + \partial i + \tau j + \Sigma ij$, in which$Yij$ = the observation results of block i and treatment j, μ = the median of observation results, ∂i = effect of block to -i, τj = treatment effect to -j danΣij = the effects of errors in the block to -i and treatment to -j.If the observations showed statistically significant differences, proceed with the average difference test with the least significant difference (LSD) test..

In order to find out the tolerance of each variety to cob rot and the performance of their respective results, an observation was made on the climate components that influence the development of pathogens that cause cob rot disease and observations of agronomic data.The observed climate data is rainfall during the research. While the agronomic data parameters measured, among others: plant height, cob diameter, cob length containing seeds, number of seed rows per cob, number of seeds per row, number of seeds per cob, husk cover on cob, intensity of cob rot disease, dry seed production per plot and weight of 1.000 seeds.

Results and Discussion

Plant Height, Cob Diameter, and Seed Length which Contained Seeds

The LSD test results of measurement of plant height, cob diameter, and cob length which contained seeds in several types of hybrid corn varieties can be seen in table 1.

Table 1: The Results of Average Difference Test in Plant Height, Cob Diameter and Cob Length which Contained Seeds

Type of Varieties	Plant Height (cm)	Cob Diameter (cm)	Seed Length which Contained Seeds (cm)
V_1	188,00 c	2,27	19,89
V_2	199,40 b	2,20	19,64
V_3	178,50 d	2,62	22,26
V_4	211,20 a	2,54	17,85
V_5	178,90 d	2,52	17,54
V_6	198,80 b	2,42	16,41
V_7	217,10 a	2,68	17,27

Note: Numbers followed by the same letter notation in the same column stated that they are not significantly different at the 5% level.

Based on table 1, it was known that the type of variety affected the plant height. While the cob diameter and cob length which contained seeds were not affected by the difference in varieties. The highest plants were found in varieties V7 (217.10 cm) followed by varieties V4 (211.20 cm), V2 (199.40 cm), V6 (198.80 cm) V3 (178.50 cm) and the lowest in varieties V5 (178.90 cm). Plant height was influenced by the type of variety planted. This was in line with the description of each variety tested, not all of which produce the same plant height.

The different types of hybrid corn varieties do not affect the cob diameter. The highest cob diameter was found in treatments V7 (2.68 cm) followed by V3 (2.62 cm), V4 (2.54 cm), V5 (2.52 cm), V6 (2.42 cm), V1 (2 , 27 cm) and lowest in V2 (2.30 cm). The highest cob diameter was found in treatment V7, where one of the advantages of this variety was declared resistant to cob rot disease, hence the growth of corn cobs was not disturbed *(http://cybex.deptan.go.id/penyuluhan/jagung-hibrida-varietas-Bisi 2).*

The results of measuring the cob length which contained seeds in several types of varieties tested showed that the difference in varieties did not affect the cob length which contained seeds. The highest cob length which contained seeds was found in variety V3 (22.26 cm) followed by varieties V1 (19.89 cm), V2 (19.64 cm), V4 (17.85 cm), V5 (17.54 cm) , V7 (17.27 cm) and lowest was in variety V6 (16.41 cm). The difference in physiological and morphological characteristics of each corn variety can influence the development of cob rot disease. Varieties that produce husk which is able to cover the cob to the tip completely, relatively tolerant to cob rot disease and vice versa (Girsang, 1999).

Number of Seed Rows per Cob, Number of Seeds per Row, Number of Seeds per Cob and Husk Cover on Cob (%)

LSD test results on the average number of seed rows per cob, number of seeds per row, number of seeds per cob and husk cover on cob on several types of hybrid corn varieties tested can be seen in table 2.

Table 2: Average Difference Test Results on Number of Seed Rows per Cob, Number of Seeds per Row, Number of Seeds per Cob and Husk Cover on Cob (%)

Type of Varieties	**Number of Seed Rows per Cob**	**Number of Seeds per Row**		**Number of Seeds per Cob**		**Husk Cover on Cob (%)**		
						Arc Sin		**Score**
V_1	13,47	44,27	a	593,39	a	98,9	a	2
V_2	12,53	36,70	b	461,85	bc	98,2	b	2
V_3	13,80	30,36	d	438,39	c	89,8	d	4
V_4	14,13	28,06	d	408,61	c	86,2	e	4
V_5	14,93	30,73	d	456,42	bc	93,5	c	3
V_6	15,10	35,70	bc	538,85	ab	85,0	f	4
V_7	14,93	31,55	cd	480,82	bc	83,2	g	5

Note: The numbers followed by the same letter notation in the same column are not significantly different at the 5% level.

The measurement results on the number of seed rows per cob showed that differences in varieties did not affect the number of seed rows per cob. The highest number of seed rows was found in varieties V6 (15.10) followed by V5 and V7 (14.93), V4 (14.13), V3 (13.80), V1 (13.47) and the lowest in V2 (12.53). Corn plants require technical culture requirements to increase production. The technical culture, besides the use of superior seeds, it also needed fertilization, plant spacing, population density per unit area, breeding and control of plant-disturbing organisms (Girsang, 1999).

The highest number of seed rows per cob was found in variety V1, which was not significantly different from varieties V6, and V2, but significantly different from varieties V4, V3, V5 and V7. The production potential of each variety was different. There were certain varieties that were superior and can increase corn crop production (Sugeng, 1983). Vice versa, by using seeds that were not good in quality, plants that grow will produce low productivity.

Based on table 2, it was known that different varieties affect the ability to produce the number of seeds per cob. The highest number of seeds per cob was produced by variety V1 (593.39) followed by varieties V6 (538.85), V7 (480.82), V2 (461.85), V5 (456.42) V3 (438.39), and lowest at V4 (408.61). Variety V1 was not significantly different from variety V6, but significantly different from varieties V2, V3, V4, V5 and V7. Superior varieties that are high yielding, resistant to pests and stable in various targets can increase the yield of corn plants. Soeprapto (1987), stated that corn varieties that are ideal for increasing production are characterized by characteristics such as; seed yield per unit area is quite high, responsive to fertilization, short-lived, tolerant to pests and diseases and is able to adapt to various types of environment, the shape of the stem is sturdy and resistant to lodging, the skin of the corn husk covered tightly closed cobs, hard seeds with a uniform color and seed protein content is high enough.

Types of corn varieties affect the husk cover on cob. The highest husk cover on cob was found in varieties V1 (98.9%) followed by V2 (98.2%), V5 (93.5%), V3 (89.8%), V4 (86.2%), V6 (85.0%) and lowest in V7 (83.2%). Varieties that have husk cover on cob to the tip perfectly are relatively tolerant to cob rot disease. Conversely, the tip of the cob is not completely covered with husk will be sensitive to cob rot disease.

The Intensity of Cob Rot Disease, the Amount of Dry Production per Plot and Weight of 1.000 Dried Seed Grains

LSD test results on the measuring data of the intensity of cob rot disease, the number of production and weight of 1.000 grains of dried seeds produced on the tested varieties were listed in table 3.

Table 3: Average Difference Test Results on Cob Rot Disease Intensity, Dry Production per Plot and Weight of 1.000 Dried Seed Grains

Type of Varieties	Intensity of Cob Rot Disease (%)			Dry Production			Weight of 1.000 Dried Seeds (gr)	
	Arc Sin		Category	Per Plot (kg)	Conversion per Ha (ton)			
V_1	2,00 (8,13)	b	Mild (0-10%)	8,90	9,493	ab	334,66	a
V_2	6,00 (14,05)	b	Mild (0-10%)	7,66	8,170	b	305,33	b
V_3	10,66 (18,36)	b	Medium (>10-25%)	9,10	9,706	ab	336,00	a
V_4	2,66 (9,26)	b	Mild (0-10%)	9,83	10,485	a	337,33	a
V_5	18,66 (19,13)	b	Medium (>10-25%)	10,90	11,626	a	340,00	a
V_6	40,00 (39,14)	a	Severe (>75%)	9,83	10,485	a	337,33	a
V_7	52,00 (45,95)	a	Severe (>75%)	10,33	11,018	a	339,66	a

Note: The numbers followed by the same letter notation in the same column are not significantly different at the 5% level.

Based on table 3, it was known that different varieties produce different intensities of cob rot disease. The intensity of cob rot disease which was categorized as severe was found in varieties V7 (52%) and V6 (40%). The medium category was found in varieties V3 (10.66%) and V5 (18.66%) and mild categories were in V1 (2%), V2 (6%), and V4 (2.66%). Cob rot disease is related to the husk cover on cob. Cob rot disease in corn plants is generally caused by fungal pathogens (http://balitsereal.litbang.deptan.go.id). Cob rot can be caused by several species of fungi, such as Fusarium, Diplodia and Gibberella (http://khasindonesia.blogspot.com/busuk-tongkol-fusarium-pada-jagung.html, 2011) these pathogens generally proliferate in rainfall conditions and high humidity.

The factual condition showed that the tolerance of the corn varieties was different on cob rot disease. Under the same conditions of the place, season, environment and technical culture treatment, some varieties are relatively resistant, and conversely, some varieties are more sensitive. The different biological properties of corn varieties also influence the development of cob rot disease. Varieties that produce husk that can cover the cob up to the tip perfectly, are relatively tolerant of cob rot disease. Conversely, varieties whose cob tip is not completely covered with husk will be sensitive to cob rot disease (Subandi, 1999). This is because, in the cob that is not completely covered with husk, water easily enters the inside of the cob and causes pathogens that cause rot proliferate and spread, causing the seeds attached to the cob to rot. In the V1 variety, the husk cover reaches 98.9%, hence the percentage of cob rot is also relatively small, reaching only 2%.

The highest amount of dry production per plot was produced by varieties V5 (10.90 kg), not significantly different from V7 (10.33 kg), but significantly different from varieties V2 (7.66 kg), V1 (8.90 kg), V3 (9:10 kg) V5 (9.83 kg), V6 (9.83 kg). The use of superior seeds is one of the factors that play an important role in planting corn (Suprapto, 1987). In order to increase corn production, it is better to use quality seeds.

Potential production based on the description of each variety also affects production per unit area. As in the Pioneer 29 (V1) variety, the description of the yield potential is 10.8 tons/ha and the average production per hectare is 8.1 tons. While data from the results of research conducted produced an average production per hectare in treatment V1 reaching 9.493 tons. Production of research results is not much different from the potential results listed in the description data. Likewise, with the treatment of other varieties, the production obtained does not differ greatly with the potential results stated in the description of each variety.

The results of weighing on 1.000 dry grains of the tested varieties showed that the different types of hybrid corn varieties affected the weight of 1.000 grains produced. The highest weight of 1.000 dry seeds was found in the treatment V5 (340.00 gr) followed by V7 (339.66 gr), V4 (337.33 gr), V6 (337.33 gr), V3 (336.00 gr), V1 (334.66 gr), V2 (305.33 gr).The weight of 1.000 dry seeds illustrated the quality of seeds produced by these varieties. The greater the weight of 1.000 dry grains, the better the quality of the corn kernels compared to the varieties with lower 1.000 grains weight. In order to increase the production of corn plants must use quality seeds in this case superior seeds (Sugeng, 1983). By using seeds that are of poor in quality, growing plants will produce low productivity.

Conclusions and Suggestions

Conclusions

1. Several varieties of hybrid corn grown in the highlands of Simalungun Regency that were tolerant to cob rot disease were Pioneer-29, NK22 and NK99, where the intensity of attacks was classified as mild (0-10%). The varieties of Pioneer-12, Pioneer-4, resistance to cob rot disease were in the moderate category (> 10-25%). The varieties which were more affected by cob rot disease were Nusantara-I and Asia-I varieties, which were classified as severe attack categories (> 25-70%).
2. The growth and production of several hybrid corn varieties grown in the highlands of Simalungun Regency were significantly different. The highest plants were found in Asian-I varieties and the lowest in Pioneer-4 varieties. The highest number of seeds per row was found in the treatment of Pioneer-29 varieties and the lowest was in the NK-22 varieties. The highest number of seeds per cob was found in the Pioneer-29 variety and the lowest was in the NK-22 variety. The best husk cover on the cob was found in the treatment of variety NK-99 where the husk covered well all the cob. Poor husk cover was found in Asian-I varieties, husk covered the cob incompletely hence the tip of the cob is visible. The highest amount of dry production per plot was found in the Pioneer-4 treatment and the lowest was in NK-99. The highest dry weight of 1.000 seeds was found in the Pioneer-4 treatment, and the lowest was in the NK-99 treatment. Production components: cob diameter, cob length and the number of seed rows per cob were not significantly different between varieties.

Suggestions

In order to prevent the attack of cob rot disease in the highlands of Simalungun Regency it is better to use seeds of Pioneer-29, NK22 and NK99 varieties.

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