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The Effect of Artificial Crossing on The Yield of Several Corn Varieties (*Zea mays* L.)

Wira Hadianto, Zahara, Evi Julianita Harahap*, Muhammad Afrillah, Mawaddah Putri Arisma Siregar, Nhyra Kamala Putri, Maulidil Fajri

Study Program of Agrotechnology, Faculty of Agriculture, Universitas Teuku Umar
Jl. Alue Peunyareng, Gunong Kleng, Meureubo District, West Aceh Regency, Aceh, 23681, Indonesia
*email: evijulianita@utu.ac.id

ABSTRACT

Corn is one of the food crops cultivated in Indonesia. Efforts to increase corn production can be done in various ways, one of which is by artificial crossbreeding. The research was conducted at the Experimental Garden of the Faculty of Agriculture, Teuku Umar University from November 2020 to March 2021. The experimental design used in the study was a non-factorial Randomized Block Design (RAK) with 3 replications. The factors observed for Corn Varieties in the vegetative phase were: (1) Pulut Uri (P), (2) Srikandi Kuning (K), and (3) Srikandi Ungu (U). If the F test is significantly different, it is continued with the smallest significant difference test (LSD) with a level of 5%. The results of the study showed that the artificial crossbreeding of U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂) was significantly different in the parameters of the diameter of the husked cob and the length of the cob without the husk. Artificial cross U♀ x P♂ x K♂ (Purple Srikandi♀ x Pulut Uri♂ x Yellow Srikandi♂) long cob with husk.

Keywords: Artificial Crossbreeding of Corn, Corn, Purple Srikandi, Sticky Rice, Yellow Srikandi, Purple Srikandi

1. INTRODUCTION

Corn (*Zea mays* L.) is one of the main food crops besides rice in Indonesia, the need for which continues to increase every year. The need for corn is not only for direct consumption but also for animal feed and other industrial materials. The national need for corn, which increases every year, can be overcome by land extensification and variety development through plant breeding programs (Widanni and Sugiharto 2019). The cultivation of corn (*Zea mays* L.) has a good prospect as well as demand of corn going increase mainly for food industry (Asridawati and Febriyanti 2019).

There are several types of corn that are consumed and processed, such as sweet corn (yellow kernels), glutinous corn (white kernels), and purple corn (purple kernels). The combination of crosses carried out on the three types of corn is beneficial for breeding program activities, especially if directed to determine the color traits that appear with the heterosis traits of the hybrid combination crosses. The role of the male and female parents combined needs to be known to obtain a good and ideal cross combination needed to produce corn with the desired traits (Maulidha and Sugiharto, 2019). Sweet corn (*Zea mays* var saccharata) and glutinous corn (*Zea mays* ssp. Ceratina) are types of corn that are commonly consumed as young corn and are liked by the community, both in rural and urban areas. In addition, because both types of corn are generally harvested young, the stems and leaves can also be used as animal feed (Riadi et al., 2015).

Corn has high genetic diversity because the plants are cross-pollinated. The genetic composition of plants with cross-pollination types in one variety will be different, so that certain characters can be selected to be developed into new varieties. Corn plants have wide diversity, especially in seed color characters. This is due to the anthocyanin or carotenoid content in corn seeds. Meanwhile, cluster analysis was carried out to determine the kinship relationship between genotypes to determine the parents in breeding activities. The opportunity to increase domestic corn production has quite large potential, namely by expanding the planting area (extensification) and increasing productivity (intensification). The aspect that affects the amount of corn production is high productivity. Increasing productivity can be done through improving cultivation techniques (appropriate land use, irrigation, fertilization and pest and disease control) and developing superior varieties through plant breeding programs, either through assembling hybrid varieties or free-pollinated varieties such as crosses (Sa'adah et al., 2022). The basic principle of breeding is the existence of diversity, especially genetic diversity. High genetic diversity values in a population will increase the effectiveness of selection (Amzeri, 2015).

Hybridization is the most potential technique as an effort to increase the yield of a plant with desired characteristics (Manto et al., 2023). The purpose of artificial crossing is to combine good characters into one new genotype, expand genetic diversity, utilize hybrid vigor and test the potential of parents (Syukur et al., 2015).

The results of the study by Riadi et al. (2015) showed that hybrid corn-2 (Secada x MSP4) produced the longest seeded cob length and the widest cob diameter, which were 17.68 cm and 49.25 mm respectively. The results of the study by Magfira et al. (2023) stated that the results of agronomic character selection stated that the tested genotypes and the comparison genotypes showed significantly different results in the stem diameter character. The SU5 genotype had an average stem diameter of 20.75 mm, which was not significantly different from the SU6 genotype (18.95 mm), RK457 (19.24 mm), RK75 (17.79 mm). However, it was significantly different from the SU1 genotype (16.35 mm), SU2 (14.40 mm), SU3 (16.05 mm) and SU4 (16.93 mm).

2. MATERIAL AND METHOD

2.1. Place and Time

The research was conducted at the Experimental Garden of the Faculty of Agriculture, Teuku Umar University from November 2020 to March 2021. The research coordinates are 4008'33"N 96011'54"E

2.2. Materials and Tools

The materials used were three varieties of corn seeds, namely sticky rice, yellow srikandi, purple srikandi, buffalo manure, NPK 16-16-16 fertilizer and water. The research tools used were meters, machetes, hoes, hand sprayers, scissors, calipers, scoops, wheelbarrows, watering cans, buckets, scales, pamphlet wood, brown envelopes, stationery, plastic covers and cameras.

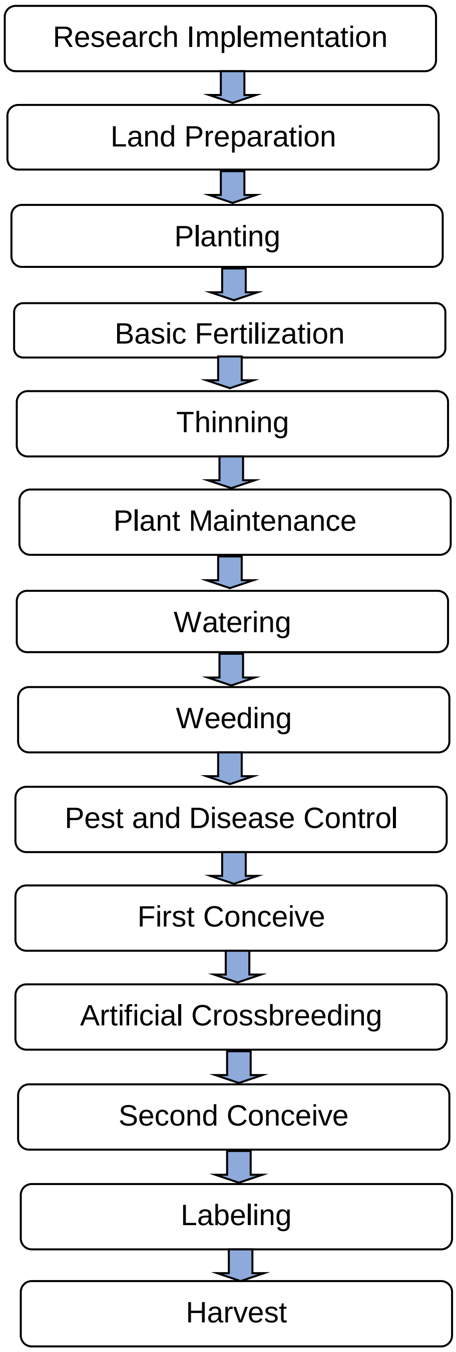

Figure 1. Research Flow Diagram

2.3. Experimental Design

The experimental design used in the study was a non-factorial Randomized Block Design (RAK) with 3 replications. The factors observed were Corn Varieties in the vegetative phase, namely: Pulut Uri (P), Srikandi Kuning (K), and Srikandi Ungu (U).

Thus, there were 3 treatments of corn varieties with 3 replications so that overall there were 9 experimental units in the vegetative phase. If the F test is significantly different, it is continued with the smallest significant difference test (LSD) with a level of 5%. The composition of artificial crosses between the three corn varieties can be seen in Table 1.

Table 1. Crossing arrangement between corn varieties

Treatment	Crossbred Varieties
P♀ x K♂	Pulut Uri♀ x Srikandi Kuning♂
P♀ x U♂	Pulut Uri♀ x Srikandi Ungu♂
K♀ x P♂	Srikandi Kuning♀ x Pulut Uri♂
K♀ x U♂	Srikandi Kuning♀ x Srikandi Ungu♂
U♀ x P♂	Srikandi Ungu♀ x Pulut Uri♂
U♀ x K♂	Srikandi Ungu♀ x Srikandi Kuning♂
P♀ x K♂ x U♂	Pulut Uri♀ x Srikandi Kuning♂ x Srikandi Ungu♂
K♀ x P♂ x U♂	Srikandi Kuning ♀ x Pulut Uri♂ x Srikandi Ungu♂
U♀ x P♂ x K♂	Srikandi Ungu♀ x Pulut Uri♂ x Srikandi Kuning♂

3. RESULT AND DISCUSSION

3.1. Stem Diameter (mm)

The average stem diameter of corn plants aged 15, 30 and 45 DAP in various varieties is presented in Table 2. Based on table 2, the stem diameter parameters were not significantly different in all treatments at the ages of 15 HST, 30 HST, and 45 HST.

Table 2. Average stem diameter of corn plants aged 15, 30 and 45 HST in various varieties

Treatment	Stem Diameter (mm)		
	15 DAP	30 DAP	45 DAP
Pulut Uri (P)	4,64	13,62	17,38
Srikandi Kuning (K)	4,81	16,37	21,14
Srikandi Ungu (U)	5,51	19,23	22,20

Description: The analyzed data were not significantly different based on the F test in the ANOVA analysis of variance.

The highest treatment was in the purple srikandi variety (U) at 5.51 mm and the lowest in the glutinous rice variety (P) at 4.64 mm at the age of 15 HST. The highest treatment was in the purple srikandi variety (U) at 19.23 mm and the lowest in the glutinous rice variety (P) at 13.62 mm at the age of 30 HST. The highest treatment was in the purple srikandi variety (U) at 22.20 mm and the lowest in the glutinous rice variety (P) at 17.38 mm at the age of 45 HST. This is because artificial crossing in several corn varieties has a different response in the environment where they live. The environment can cause the characteristics of corn that appear to be diverse. A variety has the ability to produce high yields if environmental conditions are in accordance with its growth phase, and vice versa, a variety has the ability to produce low yields if environmental conditions are not in accordance with its growth phase. According to Khairiyah et al. (2017), the differences that appear in the vegetative observation components of several types of corn varieties are the influence of genetic differences between the various varieties. According to Rahmaniah (2022), the stem diameter increment can also describe a plant's vegetative growth and flourishment. The plant's large diameter indicates that assimilation translocated to the stem is sufficient for assimilating accumulation.

3.2. Diameter of Cob with Husk (mm)

The average diameter of corn cobs from corn variety crosses after being tested with BNT0.05 is presented in Table 3. Based on table 3, the U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂) treatment had the highest cob diameter and was significantly different from other treatments, namely P♀ x K♂, P♀ x U♂, K♀ x P♂, K♀ x U♂, U♀ x K♂, P♀ x K ♂ x U♂, K♀ x P♂ x U♂, and U♀ x P♂ x K♂. This is suspected because the U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂) cross treatment is able to adapt and absorb available nutrients well.

Table 3. Average diameter of corn cobs from cross-breeding of corn varieties

Treatment	Diameter of Cob with Husk (mm)
P♀ x K♂ (Pulut Uri♀ x Srikandi Kuning♂)	42,32 bc
P♀ x U♂ (Pulut Uri♀ x Srikandi Ungu♂)	38,73 a
K♀ x P♂ (Srikandi Kuning♀ x Pulut Uri♂)	37,34 a
K♀ x U♂ (Srikandi Kuning♀ x Srikandi Ungu♂)	44,18 d
U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂)	46,84 e
U♀ x K♂ (Srikandi Ungu♀ x Srikandi Kuning♂)	43,22 c
P♀ x K♂ x U♂ (Pulut Uri♀ x Srikandi Kuning♂ x Srikandi Ungu♂)	41,46 b
K♀ x P♂ x U♂ (Srikandi Kuning ♀ x Pulut Uri♂ x Srikandi Ungu♂)	41,63 b
U♀ x P♂ x K♂ (Srikandi Ungu♀ x Pulut Uri♂ x Srikandi Kuning♂)	44,18 d
$BNT_{0,05}$	1,74

Description: Numbers followed by the same letter in the same column indicate no significant difference in the BNT0.05 test.

If plants are able to adapt and absorb nutrients well, they will activate patisintase in the plant body which will also accelerate the photosynthesis process. This photosynthesis process will channel photosynthate from the leaves to the fruit, causing the diameter of the cob with husks to form optimally. According to Ananda et al. (2023), the assimilates formed from the photosynthesis process will be distributed to various parts of the plant body. The results of photosynthesis that are translocated to the generative organs of the corn plant are used for the formation of cobs which result in the weight per cob with husks, weight per cob without husks, weight of cobs per plot, cob length and cob diameter. Tobing et al. (2022) stated that tall corn plants with many leaves will increase the plant's ability to utilize solar energy for photosynthesis. Photosynthate will be used by plants for cob growth and seed filling. Long and large-diameter cobs will increase the dry biomass weight of the biomass.

3.3. Diameter of Corncob Without Husk (mm)

The average diameter of the corn cob without the husk of the corn plant in the results of crossing corn varieties is presented in Table 4. Based on table 4, the parameters of the cob diameter without husks were not significantly different in all treatments. The highest treatment was in U♀ x P♂ x K♂ (Srikandi Ungu♀ x Pulut Uri♂ x Srikandi Kuning♂) at 40.16 mm and the lowest in K♀ x P♂ (Srikandi Kuning♀ x Pulut Uri ♂) at 31.84 mm. This is suspected of being an artificial cross in several corn varieties that have genetic traits that are less able to adapt so that the formation of the cob diameter without husks is not good. According to Kantikowati et al. (2023), cobs originating from female flowers are generative organs whose growth is influenced by the elements P and K but the element N in certain amounts can also increase the diameter of the cob. Because the needs for nutrients, light and water are met, photosynthesis will be formed properly. However, if the elements N, nutrients, light, and water are not met, it can reduce the formation of the cob diameter.

Table 4. Average diameter of the corn cob without the husk of the corn plant in the results of crossing corn varieties

Treatment	Diameter of Corncob Without Husk (mm)
P♀ x K♂ (Pulut Uri♀ x Srikandi Kuning♂)	36,67
P♀ x U♂ (Pulut Uri♀ x Srikandi Ungu♂)	34,36
K♀ x P♂ (Srikandi Kuning♀ x Pulut Uri♂)	31,84
K♀ x U♂ (Srikandi Kuning♀ x Srikandi Ungu♂)	39,12
U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂)	39,51
U♀ x K♂ (Srikandi Ungu♀ x Srikandi Kuning♂)	37,17
P♀ x K♂ x U♂ (Pulut Uri♀ x Srikandi Kuning♂ x Srikandi Ungu♂)	37,77
K♀ x P♂ x U♂ (Srikandi Kuning ♀ x Pulut Uri♂ x Srikandi Ungu♂)	38,08
U♀ x P♂ x K♂ (Srikandi Ungu♀ x Pulut Uri♂ x Srikandi Kuning♂)	40,16

Description: The analyzed data were not significantly different based on the F test in the ANOVA analysis of variance.

3.4. Length of Corn Cob (cm)

The average length of husked cobs of corn plants from crosses of corn varieties after being tested with BNT0.05 is presented in Table 5.

Table 5. Average length of husked cobs of corn plants from crosses of corn varieties

Treatment	Length of Corn Cob (cm)
P♀ x K♂ (Pulut Uri♀ x Srikandi Kuning♂)	18,93 a
P♀ x U♂ (Pulut Uri♀ x Srikandi Ungu♂)	23,66 b
K♀ x P♂ (Srikandi Kuning♀ x Pulut Uri♂)	18,61 a
K♀ x U♂ (Srikandi Kuning♀ x Srikandi Ungu♂)	23,88 b
U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂)	23,68 b
U♀ x K♂ (Srikandi Ungu♀ x Srikandi Kuning♂)	22,90 b
P♀ x K♂ x U♂ (Pulut Uri♀ x Srikandi Kuning♂ x Srikandi Ungu♂)	23,90 b
K♀ x P♂ x U♂ (Srikandi Kuning ♀ x Pulut Uri♂ x Srikandi Ungu♂)	23,39 b
U♀ x P♂ x K♂ (Srikandi Ungu♀ x Pulut Uri♂ x Srikandi Kuning♂)	27,76 c
$BNT_{0,05}$	1,36

Description: Numbers followed by the same letter in the same column indicate no significant difference in the BNT0.05 test.

Based on table 5, the U♀ x P♂ x K♂ (Purple Srikandi♀ x Pulut Uri♂ x Yellow Srikandi♂) treatment had the highest length of cob with husk and was significantly different from other treatments, namely P♀ x K♂, P♀ x U♂, K♀ x P♂, K♀ x U♂, U♀ x P♂, U♀ x K ♂, P♀ x K♂ x U♂, and K♀ x P♂ x U♂ . This is because the U♀ x P♂ x K♂ (Purple Srikandi♀ x Pulut Uri♂ x Yellow Srikandi♂) treatment has a wider canopy so that light absorption is greater so that the photosynthate produced to then be distributed to other parts of the plant is also greater when compared to other crosses. According to Saptorini and Sutiknjo (2021), the cob formation period requires sufficient photosynthate. If nutritional needs are met, the development of the cob can be maximized.

3.5. Length of Corncob Without Husk (cm)

The average length of corn cobs without husks in the results of corn variety crosses after being tested with BNT0.05 is presented in Table 6.

Table 6. Average length of corn cobs without husks in the results of corn variety crosses

Treatment	Length of Corncob Without Husk (cm)
P♀ x K♂ (Pulut Uri♀ x Srikandi Kuning♂)	14,01 a
P♀ x U♂ (Pulut Uri♀ x Srikandi Ungu♂)	16,69 b
K♀ x P♂ (Srikandi Kuning♀ x Pulut Uri♂)	13,57 a
K♀ x U♂ (Srikandi Kuning♀ x Srikandi Ungu♂)	18,57 d
U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂)	19,72 e
U♀ x K♂ (Srikandi Ungu♀ x Srikandi Kuning♂)	18,09 cd
P♀ x K♂ x U♂ (Pulut Uri♀ x Srikandi Kuning♂ x Srikandi Ungu♂)	16,98 bc
K♀ x P♂ x U♂ (Srikandi Kuning ♀ x Pulut Uri♂ x Srikandi Ungu♂)	16,28 b
U♀ x P♂ x K♂ (Srikandi Ungu♀ x Pulut Uri♂ x Srikandi Kuning♂)	17,33 c
$BNT_{0,05}$	1,11

Description: Numbers followed by the same letter in the same column indicate no significant difference in the BNT0.05 test.

Based on table 6, the U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂) treatment had the highest corn cob length without husk and was significantly different from other treatments, namely P♀ x K♂, P♀ x U♂, K♀ x P♂, K♀ x U♂, U♀ x K♂, P♀ x K♂ x U♂, K♀ x P♂ x U♂, and U♀ x P♂ x K♂. This is suspected that the U♀ x P♂ (Srikandi Ungu♀ x Pulut Uri♂) treatment is able to absorb light better than other treatments. Good light absorption affects a good photosynthesis process. If the photosynthesis process runs well, it will produce optimal photosynthate which will then affect the formation of optimal corn cob length without husk. According to Ananda et al. (2023), the length of the cob is determined by photosynthetic activity which can transfer photosynthate from leaves to seeds as food reserves. The greater the food reserves in the seeds, the larger the size of the seeds and indirectly will affect the size of the cob.

4. CONCLUSION

Artificial crosses U♀ x P♂ (Purple Srikandi♀ x Pulut Uri♂) were significantly different in the parameters of the diameter of the husked cob and the length of the cob without the husk. Artificial crosses U♀ x P♂ x K♂ (Purple Srikandi♀ x Pulut Uri♂ x Yellow Srikandi ♂) in the length of the husked cob.

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