JPPIPA 8(SpecialIssue)(2022)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Effect of *Rhizobacteria Promoting Plant Growth* (PGPR) on Character of Resulting from Crossing Resiprocal Corn with Purple Waxy Corn with Sweet Corn (*Zea mays* L.)

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Received: October 28, 2022
Revised: November 25, 2022
Accepted: December 5, 2022
Published: December 10, 2022

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DOI:
10.29303/jppipa.v8iSpecialIssue.2471

Abstract: The purpose of this study was to obtain information about the good concentration of PGPR for the growth and yield of reciprocal crosses of purple waxy corn and sweet corn (Zea mays L.), the effect of PGPR on the character of a reciprocal cross between purple waxy corn and sweet corn (Zea mays L.) and the effect of reciprocal crosses of purple waxy corn with sweet corn (Zea mays L.) on the character of maize yield. The research was conducted in Tegalgondo Village, Karangploso District, Malang Regency, East Java Province. The study was arranged in a Split-Plot Design consisting of 4 main plots (PGPR Concentration) V0 (Without PGPR), V15 (15 ml PGPR / l water), V30 (30 ml PGPR / l water), V45 (45 ml of PGPR/ l of water) and consisted of 4 subplots (crosses) PW (Purple Waxy Maize), PWSC (Purple Waxy Corn♂ x Sweet Corn♀), SC (Sweet Corn) and SCPW (Sweet Corn♂ x Purple Pulut Corn).). The data obtained were analyzed using the Analysis of Variance (ANOVA) at the 5% level. If there is a significant effect between treatments, it is continued with a comparison test with a 5% LSD test using Costad software and Microsoft Excel. Based on the results, it can be concluded that there is an interaction between the administration of PGPR and the reciprocal cross of purple waxy corn x sweet corn on the observation of sugar content characters. PGPR treatment with PGPR concentration of 45 ml/l water (V45) can increase growth and yield characteristics. The results of the reciprocal crosses (PWSC) of Purple Waxy Maize x Sweet Corn and (SCPW) Sweet Corn x Purple Waxy Maize showed that the female parents were more dominant than the male parents.

Keywords: Corn character; Corn types; Functional food; PGPR; Reciprocal crosses

Introduction

Functional food increases along with the increase in degenerative disease sufferers and the elderly population. To improve the quality of functional food various commercial product development. According to Suarni et al., (2013) that functional food is a food ingredient that has many ingredients or components of bioactive compounds that can provide physiological effects that function on the body, among others to strengthen the immune system, maintain physical condition, slow down aging, and help prevent disease.

Research results Widjaya et.al (2001); Suarni, (2011) shows that a good diet can maintain a healthy body. This can be seen in several different food patterns that show different tendencies in life expectancy and the status of the elderly. So the food industry has shifted its focus to combining functional ingredients, using inexpensive and simple technologies to prepare healthy snacks. Some of the healthiest foods currently available on the market are made without expansion. and most are made from corn or other nixtamalized flours.

Corn as a functional food source contains a lot of fiber needed by the body (dietary fiber) with a relatively low glycemic index (GI) compared to rice from rice, so corn rice is a recommended ingredient for diabetics. The GI range for rice is 50-120 and for corn rice is 50-90, these values are very relative, depending on the variety. Corn grain is 72% starch, with the remainder consisting primarily of protein, fat, and fiber, and contains

How to Cite:
Ishartati, E., Setyawan, M.T., & Fadjri, I.A. (2022). Effect of Rhizobacteria Promoting Plant Growth (PGPR) on Character of Resulting from Crossing Resiprocal Corn with Purple Waxy Corn with Sweet Corn (Zea mays L.). *Jurnal Penelitian Pendidikan IPA*, *8*(SpecialIssue), 12–21. https://doi.org/10.29303/jppipa.v8iSpecialIssue.2471

significant amounts of linoleic acid, which is an essential fatty acid (Woo et al., 2018). In addition, corn kernels have a variety of colors, ranging from white, yellow, red, orange, purple to black. The color diversity of corn kernels shows that corn contains a lot of anthocyanins, carotenoids and others (Suarni et al., 2013). The current problem is the lack of corn production for functional food. One effort that can be made to overcome this problem is by administering PGPR during the vegetative phase and carrying out crosses between different characters (reciprocal crossing). Technically, reciprocal crosses are carried out by transferring male flower pollen to plants with other varieties as female parents.

This study aims to obtain information about good concentrations of PGPR, and the effect of PGPR, as well as the effect of reciprocal crosses of pulut-purple maize and sweet corn (Zea mays L.) on the yield characteristics of maize.

Method

Time and place

The research was conducted in Tegalgondo Village, Karangploso District, Malang Regency, East Java Province.

Materials and Tools

The materials needed in the research included purple F1 male pulut corn seeds with red arrow caps, sweet corn seeds var. talent, PGPR, manure, inorganic fertilizers (NPK, MKP and SP vertipos), herbicides (roud up), insecticides (regen 50SC, Prevathon 50SC and furadan), fungicides (Cabrio Gold 183SE), wrapping paper, plastic, clips, mulch.

The tools used in the research included agricultural tools, mulch punch, sprayer, measuring tools (meter and ruler), raffia rope, trays, bellows, calipers, measuring cups, scissors, scales, buckets, stationery and documentation tools.

Research methods

The study was arranged in a Split-Plot Design consisting of 4 main plots and 4 sub-plots, namely: Main Plot includes, V0 : Without PGPR, V15 : 15 ml PGPR/ l water), V30 : 30 ml PGPR / l water and V45 : 45 ml PGPR/ l water. Subplots include, Prosecutor : Purple-pulp corn, JPUM : Purple-pulp corn♂ x sweet corn♀, JM : Sweet corn and JMPU : Sweet corn♂ x purple-pulp corn♀. So that a total number of treatments was obtained as many as 16 combinations of treatments, each of which was repeated 3 times, plant samples were taken randomly. The number of beds needed is 48 beds with a width of 40 cm, a height of 30 cm and a length of 200 cm. Spacing of 30 cm, distance between beds 60 cm and distance between repetitions 70 cm. The number of samples of seed plants was 3, the number of seed plants was 6.

Procedure

The implementation of the research began with clearing the land from weeds, then continued with tillage using a tractor. Making beds is done manually using a hoe. Before planting in the field, the corn seeds are first sown on the seedling tray. Planting is carried out after the sown corn seeds are 7 days old or already have 2-3 leaves. PGPR was applied at the time of transplanting, and when the plants were 7 and 14 hst. Stitching is done to replace plants that die or grow abnormally. Fertilization is done when the plants are 10 hst, 20 hst, 30 hst. Control of pests and diseases in the growth phase to harvest is carried out by spraying insecticides and fungicides. Weed control is done by spraying herbicides. Pembumbunan done to cover the roots or the base of the stem. The crossing was carried out reciprocally, that is, crossing the male parents of purple pulut corn and the female parents of sweet corn, and vice versa between the male parents of sweet corn and the female parents of purple pulut corn. Corn harvesting is done when the plants are 75-80 HST. Observation of the results was carried out after the harvesting process was complete, observing the results included observing the character of the corn cobs and seeds.

Observational variable

Parameters observed included (1) Growth (plant height, stem diameter, number of leaves, leaf area, flowering time of male flowers and flowering time of female flowers. (2) Quantitative results of cob and seed characters (fresh weight of cobs + husks, fresh weight without husks) , dry weight, cob length, cob stalk length, cob diameter, cob diameter, rachis diameter, number of rows, number of seeds per row, weight of 100 seeds, seed length, seed width, seed thickness, sugar content) (3) Qualitative characters (top cob shape, cob color, seed row arrangement, seed type, seed color, and seed surface shape).

Data analysis

The data obtained were analyzed using Analysis of Variance (ANOVA) at the 5% level. If there is a significant effect between the treatments, continue the comparison test using the LSD test at 5% level.

Result and Discussion

The results of the analysis of variance on the observations of maize plant growth table 1 showed significantly different results for the parameters of plant height, leaf area, early appearance of male flowers and early appearance of female flowers on the factors of cross treatment. The character of corn cobs table 2 showed significantly different results on the characters fresh weight + husks, fresh weight without husks, dry weight, cob length, cob stalk length, cob diameter, cob diameter and rachis diameter on the cross factor. Corn seed characters table 3 showed significantly different results on the characters of the number of rows of seeds, the number of seeds per row, the weight of 100 g, the length of the seeds, the width of the seeds and the thickness of the seeds. The character of sugar content table 4 shows an interaction between the PGPR factor and the crossing. The qualitative character of corn table 5 shows that there is a significant change in the character of the seed color and the color of the cob.

Growth of Corn Plants (Zea mays L.)

Based on the results of the corn plant growth analysis Table 1, the results were not significantly different in all concentration treatments of PGPR administration and cross treatments, except for the observation variables of plant height, number of leaves, early appearance of male flowers and early appearance of female flowers. It is suspected that the provision of PGPR with a certain concentration has an indirect effect on the growth of corn plants. The results of observations showed that the V45 treatment (45 ml PGPR / l water) had the highest average growth in the observation variable plant height 100.11 cm, stem diameter 2.2 cm and had the fastest female flower appearance at 53.9 hst. As for the cross treatment, it showed that purple pulut corn had the highest average growth in plant height of 103.69 cm, had the fastest average of the first male flowers to appear 44.5 dap and the first male flowers to appear 51.6 dap. For sweet corn, the results showed that it had the highest average in the treatment of the number of leaves 9.84 cm and the leaf area of 250.17 cm². Based on the results of observations, it was shown that the treatment of PGPR concentrations and differences in corn plant varieties had an indirect effect on the growth of corn plants.

Table 1. Results of Analysis of Variance on the Growth of Corn (Zea mays L.)

Treatment	Variable					
	TT (cm)	DB (cm)	JD (sheet)	LD (cm²)	BJ (hst)	BB (hst)
PGPR Concentration						
V_0 (without PGPR)	95.98	2.09	9.6	226.81	48.65	54.05
V_{15} (15 ml PGPR /l water)	98.28	2.17	9.8	236.1	48.66	54.24
V_{30} (30 ml PGPR /l water)	99.58	2.14	9.7	239.21	48.7	54.22
V_{45} (45 ml PGPR /l water)	100.11	2.2	9.73	237.39	48.8	53.9
BNT α 5%	Ns	ns	Ns	Ns	Ns	Ns
Cross						
Jpu (Purple Pulut Corn)	103.69b	2.19	9.6	221.91a	44.5a	51.6a
Jpum (Purple pulut corn ♀ x Sweet corn ♂)	103.04b	2.21	9.5	227.95ab	44.53a	51.8a
Jm (Sweet Corn)	94.82a	2.1	9.84	250.17b	52.8b	56.2b
Jmpu (Sweet Corn♀ x Purple Pulut Corn ♂)	92.4a	2.1	9.82	239.48b	52.9b	56.6c
BNT α 5%	3.61	ns	Ns	15.95	0.24	0.25

Note: Numbers in the same column followed by the same letter are not significantly different based on the BNT test at the 5% level, TT = plant height; DB = stem diameter; JD = number of leaves, LD = leaf area; BJ = male flower; BB = female flower.

Based on the results of the analysis in Table 1, it shows that the purple corn variety has the highest average growth in the characters of plant height, stem diameter, the first male flowers to appear and the first female flowers to appear. As for the sweet corn variety, it has the highest average growth value on the number of leaves and leaf area characters. Then for the factor of PGPR, although the results of the analysis of variance showed no significant effect, the growth of maize plants that were given PGPR with a concentration of 45 ml/l water had the highest average growth in the characters of plant height, stem diameter, leaf area, and 45 PGPR. ml/l of water accelerates the appearance of female corn flowers. According to Sari (2018) giving higher concentrations of PGPR is thought to increase the microbial population of PGPR so that it helps plants optimally absorb and provide nutrients which can increase plant growth and yield. Meanwhile, according to Iswati (2012) that the higher the concentration of PGPR application, the greater the effect on plant height.

Yield Quantitative Characteristics of Maize (Zea mays L.)

In contrast to qualitative characters, quantitative characters require measurement. Quantitative character observations included cob yield characters (fresh weight + husks, fresh weight without husks, dry weight, cob length, cob stalk length, cob diameter, cob diameter and rachis diameter), and seed yield character components (number of seed rows, number of seeds per row, 100 seed weight, seed length, seed width and seed thickness).

Based on the results of cob character analysis table 2, the results were not significantly different at all concentrations of PGPR. Meanwhile, the cross treatment showed significantly different results on the observed variables except for the janggel diameter. With the highest mean in the treatment of PGPR concentration was (V45) in the observation variable fresh weight of cobs with cobs of 363.3 g, fresh weight of cobs without husks of 266.8 g, cob stalk length 9.3 cm, cob diameter 4.78, cob diameter 2.52 and rachis diameter 1.458 cm except in variable dry weight 163.1 g and cob length 20.2 the highest average in the (V30) treatment. Meanwhile, the results of the crosses showed that the (JM) and (JMPU) treatments had the highest mean on all observation variables compared to the (JPU) and (JPUM) treatments.

Table 2. Results of Analysis of Variance on Character Results of Corn Cobs (Zea mays L.)

Treatment	Variable							
	BSK (g)	BSTK (g)	BK (g)	PTk (cm)	PTTk (cm)	DTk (cm)	DJ (cm)	DR (cm)
PGPR Concentration								
V_0 (without PGPR)	316.7	237.5	147.9	19.4	9.23	4.5	2.4	1.37
V_{15} (15 ml PGPR /1 water)	326.1	250.3	155	19.6	9.2	4.7	2.42	1.4
V_{30} (30 ml PGPR /1 water)	349.5	260.5	163.1	20.2	8.9	4.74	2.5	1.45
V_{45} (45 ml PGPR /1 water)	363.3	266.8	156.1	19.8	9.3	4.78	2.52	1.458
BNT α 5%	Ns	Ns	Ns	Ns	ns	ns	ns	ns
Cross								
Jpu (Purple Pulut Corn)	260.4a	216.1a	132.3a	17.9a	8.05a	4.52a	2.44	1.35a
Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	253.2a	210.01a	126.1a	17.7a	8.3a	4.48a	2.43	1.34a
Jm (sweet corn)	436.08c	299.3b	189.2c	21.4b	10.06b	4.97c	2.5	1.5b
Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	406.01b	289.8b	174.4b	21.9b	10.2b	4.83b	2.46	1.4b
BNT α 5%	27.8	22.24	12.4	0.85	0.38	0.11	ns	0.094

Note: Numbers in the same column followed by the same letter, not significantly different based on the BNT test at the 5% level, BSK = fresh weight of cobs + cornhusk; BSTK = fresh weight of cob without husk; BK = dry weight; PTk = cob length, PTTk = cob stalk length; DTk = cob diameter; DJ = jangle diameter; DR = rachis diameter.

The results showed that the PGPR concentration treatment had no significant effect. This is in accordance with the statement of Halmedan et al., (2017) that the administration of PGPR and chicken kendang manure can increase cob weight with husks and cob weight without husks because the administration of PGPR contains microorganisms so that it is able to increase root nutrient uptake, support nutrient uptake by reducing the level of heavy metal poisoning and against pathogens. Whereas the results of crosses show a significant effect, this is in accordance with the results of research by Ui et al., (2015) that the length of corn cobs in reciprocal crosses of local glutinous corn with sweet corn makes the number of rows of seeds increase and will increase the weight of the cobs. According to Ningrum et al., (2017) that PGPR bacteria indirectly have the ability to provide important nutrients for plants such as nitrogen, phosphate, sulfur, potassium and iron ions. With the availability of nutrients for plants, plant growth will increase. The research results of Khan et al., (2017) showed a significant increase in overall plant growth based on increased photosynthesis with nutrients and PGPR administration. Optimal photosynthate will result in increased crop yield, cob length, and cob weight supported by environmental fertility.

The results of the analysis in table 3 show that the PGPR concentration treatment was not significantly different except for the variable number of seed rows observed. So it is suspected that the administration of PGPR with different concentrations has an indirect effect on the yield character of corn kernels. The concentration of PGPR (V45) showed the highest average for (JBP) 36.1 seeds, (PB) 1.21 cm and (TB) 0.62 cm. Meanwhile, the sample without treatment had the lowest average. Rahni (2012) suggested that PGPR can produce phytohormones namely IAA, cytokinins, gibberellins, ethylene and abscisic acid, where IAA is the active form of the auxin hormone found in plants and plays a role in increasing the quality and yield of crops.

As for the cross treatment, the results were significantly different except for the variable length of the seeds and the thickness of the seeds. This is because reciprocal crosses will produce new genotypes that affect the yield character of corn seeds. The results of research on the yield characteristics of maize seeds showed that there was a significant influence of male and female parents (xenia effect), so that crossed maize would inherit the characteristics of both parents. These results are in accordance with Hariyanti's research (2014) that there is the influence of the male parent which is expressed directly on the character of the seeds, this statement is in accordance with Fatimah, et al (2015) that the crosses produced and the number of seeds are a sign that the parents of the crosses have a good level of compatibility.

The results of the analysis of variance in [Table 4] show that there is an interaction between the PGPR and the cross on the sugar content character. These results indicate that there is a very significant effect between treatment combinations. From the observations, it was found that the V15JM treatment combination had the highest average sugar content value of 14.27% brix, while the treatment that had the lowest average sugar content was the V15JPU treatment with a value of 3.97 brix. These results indicate that sweet corn has the highest average value of sugar content, compared to the other treatments.

Table 3. Results of Analysis of Variance on Yield Characteristics of Corn Seed (Zea mays L.)

Treatment						Variable
	JBB (seed)	JBP (seed)	B100 (g)	PB (cm)	LB (cm)	TB (cm)
PGPR Concentration						
V_0 (without PGPR)	14.7	31.4a	16.6	1.2	0.9	0.5
V_{15} (15 ml PGPR /l water)	14.9	34.5b	16.8	1.17	1.03	0.61
V_{30} (30 ml PGPR /l water)	15.4	34.9b	16.87	1.18	1.02	0.62
V_{45} (45 ml PGPR /l water)	15.2	36.1b	16.7	1.21	1.01	0.62
BNT α 5%	Ns	2.76	Ns	ns	ns	ns
Cross						
Jpu (Purple Pulut Corn)	15.4b	31.9a	22.9d	1.16	0.95a	0.5
Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	14.2a	31.2a	18.3c	1.21	0.95a	0.6
Jm (Sweet Corn)	15.6b	37.6b	9.9a	1.18	1.03ab	0.61
Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	15.02b	36.1b	15.9b	1.22	1.108b	0.64
BNT α 5%	0.71	3.79	0.43	ns	0.118	ns

Notes: Numbers in the same column followed by the same letter, not significantly different based on the 5% LSD test, tn = not significant, JBB = number of seed rows; JBP = number of seeds per row; B100 = weight of 100 seeds, PB = seed length, LB = seed width and TB = seed thickness.

The results of observations on the character of sugar content showed that there was an interaction between the PGPR treatment and the cross treatment. The PGPR treatment of all concentrations combined with the JM (sweet corn) treatment had the highest sugar content on average. Whereas for the PGPR treatment, all concentrations with the J_{PU} treatment (pulut-purple corn) had the lowest average sugar content. As for the sugar content, the combined results of the PGPR treatment with the J_{PUM} treatment (sweet corn♀ x purple corn-pulp♂) had a higher average value than the PGPR treatment with J_{PUM} treatment (sweet corn♀ x purple-pulp corn♂). According to Didi et al. (2016) that sugar levels in plants can be influenced by two factors, namely factors within the plant itself and environmental factors. Internal factors are the genotypes used, while environmental factors include temperature, availability of light, water and so on. Meanwhile, according to Surtinah's research results (2008); Diddy et al. (2015) showed that different harvest ages can affect the level of sugar content in sweet corn.

Table 4. Results of Analysis of Variety of Character Results of Sugar Content in Corn (Zea mays L.)

Treatment		Sugar content (%Brix)
	JPU (Purple Pulut Corn)	4.33 a
V_0 (without PGPR)	JPUM (Purple Pulut Corn♀ x Sweet Corn♂)	7.00 b
	JM (Sweet Corn)	12.27 c
	JMPU (Sweet Corn♀ x Purple Pulut Corn♂)	11.87 c
V_{15} (15 ml PGPR /l water)	JPU (Purple Pulut Corn)	3.97 a
	JPUM (Purple Pulut Corn♀ x Sweet Corn♂)	7.43 b
	JM (Sweet Corn)	14.27 d
	JMPU (Sweet Corn♀ x Purple Pulut Corn♂)	10.83 c
V_{30} (30 ml PGPR /l water)	JPU (Purple Corn Corn)	4.03 a
	JPUM (Purple Pulut Corn♀ x Sweet Corn♂)	6.87 b
	JM (Sweet Corn)	14.17 d
	JMPU (Sweet Corn♀ x Purple Corn Corn♂)	11.37 c
V_{45} (45 ml PGPR/l water)	JPU (Purple Corn Corn)	4.53 a
	JPUM (Purple Pulut Corn♀ x Sweet Corn♂)	6.93 b
	JM (Sweet Corn)	14.10 d
	JMPU (Sweet Corn♀ x Purple Pulut Corn♂)	12.27 c
BNT α 5%		0.77

Note: Numbers in the same column followed by the same letter are not significantly different based on the BNT test at the 5% level.

Qualitative Characteristics of Maize (Zea mays L.) Yield

Observation results in table 5 show that the topmost cob shape variable (BTPA) shows various results. However, of all the treatment samples, the average cob shape was at the top of the cone, and the cob samples that had a very small round shape. The results of the observation on the color of the janggel (WJ) showed that the result of reciprocal crosses had quite an effect on the change in the color of the janggel of the female parents of purple pulut corn with the male parents of sweet corn (JPUM) which previously had a purple janggel color, after being crossed with the male parents of sweet corn it produced a purple janggel color vaginal discharge as in Figures 1 and 2. Meanwhile, the color of the janggel in the results of the JMPU cross (Sweet corn♀ x Purple pulut corn♂) did not change Figures 3 and 4. In observing the results of the arrangement of the reciprocal crosses, there was no significant effect. This indicated that there was no significant change between the parental samples and the crosses. So it is suspected that the male and female parents have quite an effect on the change in janggel color.

Table 5. The percentage of crosses of qualitative characters of maize (Zea mays L.)

Treatment		Variable										
		BTPA (%)				WJ (%)			SBB (%)			
		Round	Cone	Cylindrical	Conical astigmatism	Purple	White	Purplish white	Straight	Curved	Regular	Irregular
V_0	Jpu (Purple Pulut Corn)	0	65 %	35%	0	100 %	0	0	100 %	0	0	0
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	0	100 %	0	0	0	0	100%	0	35%	35%	30%
	Jm (Sweet Corn)	0	100 %	0	0	0	100 %	0	0	100%	0	0
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	0	100 %	0	0	0	100 %	0	0	75%	25%	0
V_{15}	Jpu (Purple Pulut Corn)	35%	0	0	65%	100 %	0	0	25%	50%	0	25%
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	0	0	75%	25%	0	0	100%	25%	45%	0	30%
	Jm (sweet Corn)	0	100 %	0	0	0	100 %	0	75%	25%	0	0
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	0	25 %	0	75%	0	100 %	0	0	0	75%	25%
V_{30}	Jpu (Purple Pulut Corn)	0	0	0	100%	100 %	0	0	25%	0	75%	0
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	0	35 %	0	65%	0	0	100%	65%	35%	0	0
	Jm (Sweet Corn)	0	100 %	0	0	0	100 %	0	30%	40%	30%	0
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	0	80 %	0	20%	0	100 %	0	0	0	65%	35%
V_{45}	Jpu (Purple Pulut Corn)	0	75 %	0	25%	100 %	0	0	100 %	0	0	0
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	0	25 %	50%	25%	0	0	100%	70%	0	0	30%
	Jm (Sweet Corn)	0	100 %	0	0	0	100 %	0	30%	0	50%	20%
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	0	100 %	0	0	0	100 %	0	25%	75%	0	0

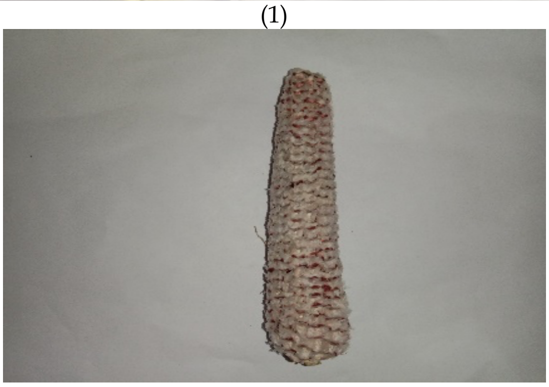
Note: The dominant color average is based on visual observations of each plant sample, BTPA = the topmost cob shape; WJ = jangle color; SBB = seed row arrangement.

Table 6. Percentage of Crosses of Qualitative Characteristics of Maize (Zea mays L.)

Treatment		TB (%)				WB (%)			Variable BPB (%)	
		Flint	Semi flint	Dent	Semi dent	Purple	Yellow	White	Round	Lined
V_0	Jpu (Purple Pulut Corn)	100%	0	0	0	100%	0	0	100%	0
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	100%	0	0	0	0	60%	40%	100%	0
	Jm (Sweet Corn)	0	0	100%	0	0	100%	0	0	100%
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	0	25%	50%	25%	0	80%	20%	10%	90%
V_{15}	Jpu (Purple Pulut Corn)	100%	0	0	0	100%	0	0	100%	0
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	70%	30%	0	0	0	25%	75%	100%	0
	Jm (Sweet Corn)	0	0	100%	0	0	100%	0	0	100%
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	5%	20%	65%	10%	0	75%	25%	15%	85%
V_{30}	Jpu (Purple Pulut Corn)	100%	0	0	0	100%	0	0	100%	0
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	100%	0	0	0	0	45%	55%	90%	10%
	Jm (Sweet Corn)	0	0	100%	0	0	100%	0	0	100%
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	0	45%	50%	5%	0	70%	30%	5%	95%
V_{45}	Jpu (Purple Pulut Corn)	100%	0	0	0	100%	0	0	100%	0
	Jpum (Purple Pulut Corn♀ x Sweet Corn♂)	90%	10%	0	0	0	40%	60%	100%	0
	Jm (Sweet Corn)	0	0	100%	0	0	100%	0	0	100%
	Jmpu (Sweet Corn♀ x Purple Pulut Corn♂)	0	10%	40%	50%	0	75%	25%	20%	80%

Note: The dominant color average is based on visual observations of each plant sample, TB = seed type; WB = seed color; BPB = seed surface shape.

(1)

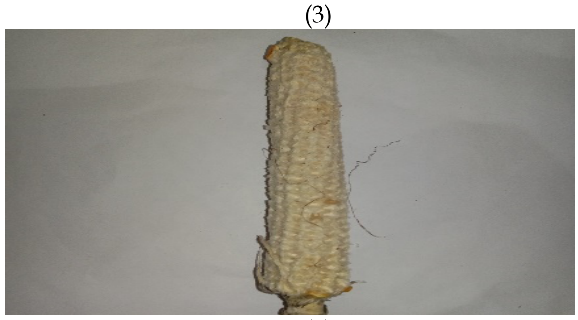


(2)

Figures 1 and 2. Changes in the color of Janggel in maize from a JPUM reciprocal cross (Purple pulut corn♀ x Sweet corn♂)

The results of observations in table 6 show that the variable type of seed (TP) F1 maize from crosses has changed. The results of the JMPU reciprocal cross (sweet corn♀ x Maize Pulut Ungu♂) show various changes as shown in Figure 6.

(3)



(4)

Figures 3 and 4. JMPU reciprocal crosses of JMPU (sweet corn♀ x Purple pulut corn♂)

In the observation of the seed color variable, there was a very significant change in the F1 results of the JPUM cross (Purple pulut corn♀ x Sweet corn♂) which on average had yellow and white seed colors from all treatment samples if on average there was no really dominant color. while for the JMPU treatment (sweet corn ♀ x Purple corn ♂) the average color is yellow and white (not dominant). Observation of seed surface shape (BPB) had no significant effect on changes in seed surface shape. This is presumably due to the dominant influence of the female parent, which influences the shape of the seed surface. This is in accordance with research from Hanafi et al., (2012) that female parents tend to contribute more to their offspring than male parents so that the traits of the offspring follow the characteristics of the female parent. Besides that, the results of a study by Ishartati et al., (2020) stated that the pollen of the male parent has homozygous alleles so that the combination of crosses follows the female parent, this is because the gene of the female parent has a dominant homozygous allele.

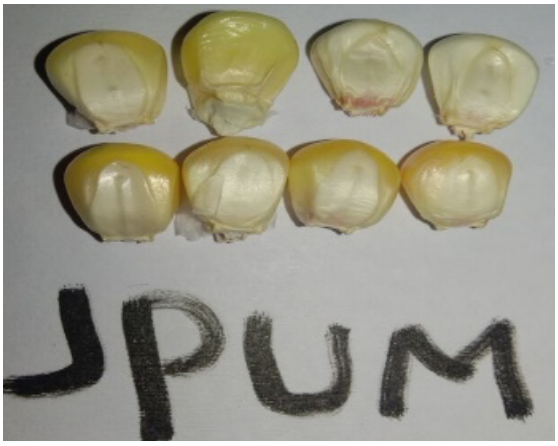


Figure 5. Changes in seed type and seed color in the F1 results of the JPUM cross (Purple pulut corn♀ x Sweet corn♂)

Figure 6. Changes in seed type and seed color in the F1 results of JMPU crosses (sweet corn♀ x Purple pulut corn♂)

According to Wardhani et al., (2014) the formation of seeds and cobs is influenced by female parents. Low yields in F1 offspring are influenced by their male parents, another factor that comes from the environment where they grow. Meanwhile, according to Bozinovic et al., (2015) states that the effect of xenia on various seed shapes is thought to be due to the character of the seed shape having a heterozygous gene arrangement, in which the expressed gene is dominant to its allele or can work together so that the expression formed is a combination of the traits of the two parents. These results indicate that the female parents of sweet corn are more dominant than the male parents of purple-pulut corn in the character of seed color, seed type, and janggel color. And it is suspected that the absence of purple corn seeds in the results of crosses (sweet corn♀ x purple-pulp corn♂) is due to the genetic color of purple-pulp corn seeds located in the female parent. In accordance with Setipu's statement (2015); Pudjiwati (2021) that female parents have a higher influence on inheritance compared to male parents. The results of the crosses can be seen in figure 7.

The results of the observation of the seeds of the J_{PUM} cross (pulut-purple corn♀ x sweet corn♂) showed that the corn kernels had a hard texture, indicating that the gene from purple-pulp corn was more dominant than sweet corn. On the other hand, the results of the observation of J_{MPU} maize seeds (sweet corn♀ x purple-pulp corn♂) show that the dominant corn seeds have a texture that is not too hard, so the results show that the gene from sweet corn is more dominant than purple corn, this indicates that sweet corn, presumably has a homozygous allele because it is a mutant maize (Bai et al., 2016). The diversity of F1 maize crosses showed that pollen expression from male parents would result in differences in size, shape, color, development time and chemical composition of seeds and fruits produced by crossing with different pollen grains. Bozinovic et al., (2015). Meanwhile, according to Kahriman et al., (2017) that the effect of xenia has a direct and specific effect on the character of the seeds.

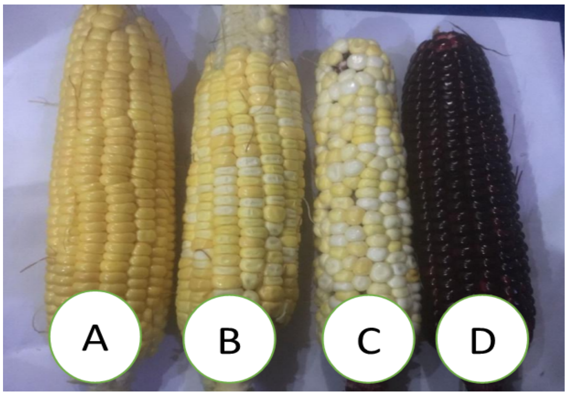


Figure 7. A) Sweet corn (JM), B) Sweet corn♀ x Purple pulut corn♂ (JMPU), C) Purple pulut corn♀ x Sweet corn♂ (JPUM), D) Purple pulut corn (JPU)

This is presumably because the crossing of parents produces heterozygous alleles. The results showed that the xenia effect affected several combinations of crosses, but did not directly change the characteristics of the female parents (cob shape, cob length, cob stalk length, cob diameter, seed row arrangement, cob diameter, rachis diameter, number of seeds per row, number of seed row). According to Mouyal and Sitrit (2004); Wardhani, et al., (2014) that the effect of xenia does not always appear in producing positive changes to several characters in each plant.

Conclusion

There was an interaction between the administration of PGPR and the reciprocal crossing of pulut-purple corn x sweet corn on the observation of the sugar content character. PGPR treatment with PGPR concentration of 45 ml/l water (V45) could increase the growth and character of reciprocal crosses of pulut-purple corn x sweet corn. The results of reciprocal crosses (JPUM) pulut-purple corn♀ x sweet corn♂ and (JMPU) sweet corn♀ x pulut-purple corn♂ show that the female parent is more dominant than the male parent. The results of the crosses also showed the influence of the xenia effect on the character of the seed type, the color of the cob, the color of the seeds and the surface shape of the corn seeds of F1 offspring.

References

Bai, F., Daliberti, M., Bagadion,A., Xu, M., Li, Y., Baier, J., Tseung, C, W., Evans, M,M,S and Settles, A, M. (2016). *Parent-of-Origin-Effect Rough Endosperm Mutants in Maize. Genetics*, Vol. 204, 221-231. https://doi.org/10.1534/genetics.116.191775

Bozinovic, S., Slaven, P., Jelena, V., Ana, N., Danijela, R., Marija, K and Dragana, I. (2015). *Individual and Combined (Plus-Hybrid) Effect of Cytoplasmic Male Sterility and Xenia on Maize Grain Yield. Journal of Agricultural Research*. 75(2) : 160 – 167. https://dx.doi.org/10.4067/S0718%2D58392015000200004

Didi, D., Idris, Lestari U.,. (2016). Evaluasi Karakteristik Keturunan Hasil Persilangan Antara Jagung Ketan Lokal (*Zea mays ceritina*) Dengan Jagung Manis Biji Putih (*Zea mays saccharata*). *Crop Agro*. 9(1). Retrieved from https://cropagro.unram.ac.id/index.php/caj/article/view/131

Fatimah, Sugiharto, AN., Ainurasjid. (2015). Persilangan Beberapa Genotif Jagung (Zea Mays L) Terhadap Karakter Biji Dan Tongkol Jagung. Jurusan Budidaya Pertaniaan. Fakultas Pertaniaan. Universitas Brawijaya. *Jurnal Produksi Tanaman*. 2 (2) : 103-110. Retrieved from http://protan.studentjournal.ub.ac.id/index.php/protan/article/view/85

Halmedan, J., Sugito, Y., & Sudiarso. (2017). Respon Tanaman Jagung Manis (Zea Mays Saccharata) Terhadap Aplikasi Plant Growth Promoting Rhizobacteria (PGPR) dan Pupuk Kandang Ayam. *Jurnal Produksi Tanaman*. 5(12):1926-1935. Retrieved from http://protan.studentjournal.ub.ac.id/index.php/protan/article/view/589

Hanafi, Ujianto L., Idris. (2012). Evaluasi Karakteristik Keturunan Hasil Persilangan Antara Jagung Lokal Berbiji Ungu (*Zea Mays* L.) Dengan Jagung Manis Berbiji Putih Bernas *(Zea Mays Saccharata Sturt*). *Jurnal Crop Agro*. 5(2): 1-7. Retrieved from https://cropagro.unram.ac.id/index.php/caj/article/view/117

Hariyanti, Ismi, D., Soegianto, A & Sugiharto, A, N. (2014). Efek Xenia pada Beberapa Persilangan Jagung Manis (*Zea mays* L. *SAccharata*) Terhadap Karakter Biji. *Jurnal Produksi Tanaman,* Volume 2, Nomor 6, Hlm. 517-523. Fakultas Pertanian, Universitas Brawijaya.

Ishartati, E., Sufianto., Fadjri, I, A., Mejaya, M, J., & Priadi, A. (2020). Efek Pollen Pada Persilangan Jagung Hitam, Pulut (*Zea Mays Ceratina*), Dan Manis (*Zea Mays Saccharata*) Terhadap Karakter Biji. *Jurnal Gontor Aggrotech Science*. 6(3): 499-515. http://dx.doi.org/10.21111/agrotech.v6i3.4911

Iswati, R. (2012). Pengaruh Dosis Formula PGPR Asal Perakaran Bambu terhadap Pertumbuhan Tanaman Tomat (Solanum Lycopersicum syn). Jurnal Agroteknotropika. 1(1):9-12. Retrieved from https://ejurnal.ung.ac.id/index.php/JATT/article/view/486

Kahriman, F, M., Serment, M., Haslak and Kang, M, S. (2017). *Pollen Effect (Xenia) for Evaluating Breeding Materials in Maize. J Genetics*. 49. 217-234. http://dx.doi.org/10.2298/GENSR1701217K

M. Khan, K. Khan, S. U. Afzal. (2017). "Seed yield performance of different maize (Zea Mays l.) genotypes under agro climate conditions of Haripur," International Journal of Environmental Sciences and Natural Resources, vol. 5, pp. 1–6. https://dx.doi.org/10.19080/IJESNR.2017.05.555672

Ningrum, W, S., Wicaksono, K, P & Tyasmoro, S, Y. (2017). Penagaruh *Plant Growth Promoting Rhizobacteria* (PGPR) dan Pupuk Kandang Kelinci Terhadap Pertumbuhan dan Produksi Tanaman Jagung Manis (*Zea mays saccharata*). *Jurnal Produksi Tanaman*. Vol. 5, No. 3 : 433 – 440 ISSN: 2527-8452. Fakultas Pertanian, Universitas Brawijaya. Jawa Timur. Retrieved from http://protan.studentjournal.ub.ac.id/index.php/protan/article/view/397

Pudjiwati, E, H & Jenar, D, K. (2021) Pengaruh Betina pada Beberapa Karakter Tanaman Jagung (*Zea mays* L.). *Jurnal Pertanian Borneo*. 4 (1) : 24-23, ISSN : 2599-2872. Universitas Borneo Tarakan. https://doi.org/10.35334/jpen.v4i1.1923

Rahni, N, M. (2012). Efek Fitohormon PGPR Terhadap Pertumbuhan Tanaman Jagung (*Zea mays*). *CEFARS : Jurnal Agribisnis dan Pengembangan Wilayah*. 3(2).

Sari, Ratna, P. (2018). Pengaruh *Plant Growth Promoting Rhizobacteria* (PGPR) dan Pupuk Kandang Sapi Terhadap Pertumbuhan dan Hasil Tanaman Jagung Manis (*Zea mays saccharate* Sturt). Skripsi. Fakultas Pertanian. Universitas Brawijaya. Malang. Retrieved from http://protan.studentjournal.ub.ac.id/index.php/protan/article/view/1111

Suarni & Yasin, Muh. (2011). Jagung Sebagai Sumber Pangan Fungsional. *Iptek Tanaman Pangan*. 6(1).

Suarni & Subagio, Herman. (2013). Potensi Pengembangan Jagung dan Sorgum Sebagai Sumber Pangan Fungsional. *J. Litbang Pert.* 32(2) 47-55.

Ui, A., Lestari, U., & Idris. (2015). Evaluasi Karakteristik Keturunan Hasil Persilangan Antara Jagung Ketan Lokal (*Zea Mays Ceritina Kulesh*) Dengan Jagung Manis Biji Putih (*Zea Mays Saccharata*). *Jurnal Crop Agro*. 1-12. Retrieved from http://eprints.unram.ac.id/id/eprint/6558

Wardhani, R. K., Purnamaningsih, S. L & Soegianto, Andy. (2014). Efek Xenia Pada Persilangan Beberapa Genotip Jagung (*Zea mays* L.). *Jurnal Produksi Tanaman*, 2(4), 347-353.

Woo, K, S., Kim, M, J., Kim, H, J., Lee, J, H., Lee, B, W., Jung, G, H., Lee, B, K and Kim, S, L. (2018). *Changes In The Functional Components And Radical Scavenging Activity Of Maize Under Various Roasting Conditions. Food Sci Biotechnol, 27(3):837–845. Department of Central Area Crop Science,* National Institute of Crop Science. Republic of Korea. https://doi.org/10.1007/s10068-017-0294-9