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Quality Test of Hybrid Corn Seeds Based on the Position of the Seeds on the Cob with a Comparison of the Parental Ratios that Have Been Applied with *Trichoderma* sp.

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Abstract: Seeds are a means of production whose quality must be guaranteed and maintained. The seed production, quality testing is an important part. This research aims to determine the effect of seed position on the cob, ratio comparison, and application of *Trichoderma* sp. on the quality of hybrid corn seeds. This research was carried out in BALITSEREAL, Maros Regency from September to October 2018. This research used a 3-factor factorial design method with a Completely Randomized Basic Design with each treatment combination consisting of 3 replications. The results showed that the position of the base seed had an effect on PK 11.63cm, JAS 4.51. The position of the middle seed has an effect on BKKN 12.31g, DHL 8.19 ($\mu mhos\ g^{-1}$cm^{-2}). A ratio of 1:2 has an effect on a JAS of 4.47. A ratio of 1:3 has an effect on a PAP of 16.84cm. *Trichoderma* sp. 10^8 has an effect on DHL 9.56 ($\mu mhos\ g^{-1}$cm^{-2}). The interaction of the position of the middle seed with a ratio of 1:2 has an effect on BKKN 12.85g. The interaction of base seed position with a ratio of 1:2 has an effect on JAS 4.77. The interaction of base seed position with a ratio of 1:3 had an effect on DB of 99.33%. The interaction between middle seed position and *Trichoderma* sp. 10^4 has an effect on BKKN 12.89g. The interaction between seed base position and *Trichoderma* sp. 10^4 had an effect on JAS 4.83, PK 12.29cm. The interaction ratio of 1:3 with *Trichoderma* sp. 10^4 has an effect on BKKN 12.39g. The interaction ratio of 1:3 with *Trichoderma* sp.10^8 has an effect on PK 11.82cm. The interaction ratio of 1:2 with *Trichoderma* sp.10^8 has an effect on JAS I4.86, DHL 8.97 ($\mu mhos\ g^{-1}$cm^{-2}). Interaction of seed base position, ratio 1:2 and *Trichoderma* sp. 10^8 has an effect on JAS 5.60. The interaction of base seed position, ratio 1:3 and *Trichoderma* sp.10^8 has an effect on PK 13.15cm. Interaction of middle seed position, ratio 1:3 and *Trichoderma* sp. 10^4 has an effect on BKKN 13.80g on the quality of hybrid corn seeds.

Keywords: Hybrid corn seeds; seed position; Ratio; *Trichoderma* sp.

Introduction

Corn is an important commodity whose role is very strategic for Indonesia (Lapui et al., 2021; Rizkika, 2023). Currently, apart from being a food ingredient, corn is also used as an industrial raw material, feed, non-oil and gas export material and a source of bioethanol (Yélamo Mayorga, 2021). The demand for corn is increasing due to the increasing population, which has an impact on food needs, consumption of animal protein and energy. Most people's consumption of animal protein comes from chicken meat. Corn is the main raw material for making animal feed, and determines the sustainability

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of national meat production (Jiao et al., 2022; Shurson, 2020; Taqiuddin et al., 2023).

The government is making efforts to realize corn self-sufficiency by increasing corn production because of the important function and role of corn, so that in the 2016 fiscal year the Government held the Hybrid Corn Development Movement activity. Through this activity, corn production is set to increase by 5% per year (Firdaus & Fauziyah, 2020). Corn production in the last four years has continued to increase from 2013 to 2016, namely 18.38 million tons of PK in 2013, 19.00 million tons of PK in 2014, 19.61 million tons of PK in 2015 (Ngawit et al., 2022). The Indonesian Ministry of Agriculture (2018) stated that corn production in 2016 increased to 23.57 million tons of PK, and in 2017 it increased by 27.95 million tons of PK (ARAM).

Seeds are plant seeds that are used for planting purposes. Seeds produced from hybrid varieties are produced from crossing two pure lines with combined beneficial characteristics, homogeneous and heterozygous offspring (Schlegel, 2009). With *hybridization,* a new type or species can be created that can increase production, be resistant to pest and disease attacks, have a short lifespan, and so on (Warisno, 2013). The use of high quality, superior varieties of corn seeds is the main key in increasing corn productivity. In this case, the government encourages the use of superior hybrid corn seeds because they have a high level of productivity. Until now, the level of use of hybrid corn seeds is still low, namely only around 60% of the total planting. The low level of use of superior seeds is partly due to the relatively high price of hybrid corn seeds making it unaffordable for most farmers (Alizah & Rum, 2020; Gunawan et al., 2022).

In one corn cob there are various sizes of seeds, some are large round usually at the base, large flat in the middle and small round at the tip of the cob (Aisah et al., 2021; Fozilov et al., 2021). The use of seeds usually only uses the middle seeds, while the base and tip seeds are used as feed, which means that only around 60% of one cob is used as seed. By testing the quality of the seeds at the base, middle and tip, you can find out the quality of the seeds so you can increase seed production. According to research by Adie et al. (2019), the position of the seeds on the corn cob influences the viability of the corn seeds.

The commonly used ratio of male to female parents in corn seed production is 2: 4 and 1: 3, meaning that 25 to 33% of the seed production plant area is occupied by male parents who are not used as seeds (Darmali, 2010). So it is hoped that by using the minimum male parent, enough pollen will still be available to pollinate the existing female plants. Thus, it is important to manage plant pollen to ensure the availability of pollen in order to increase the production and quality of hybrid corn seeds. According to research by Yuyun et al. (2017), there is an influence of plant ratio on the quality of corn seeds.

According to Suharti et al. (2018) *Trichoderma* sp. can increase plant growth and crop production. So that the corn seeds applied with *Trichoderma* sp. before planting will influence the growth and resistance of plants to disease so that the seeds produced are of good quality. *Trichoderma* sp. is an antagonistic agent that plays a role in inhibiting the growth of several plant pathogenic fungi. The advantages of the fungus *Trichoderma* sp. in control mechanisms that are target specific and capable of improving seed quality in terms of plant resistance. *Trichoderma* sp. able to increase root length and seed dry weight (Valentine et al., 2017).

Method

This research was carried out in the form of an experimental design based on a 3-factor factorial design with a completely randomized basic design (CRD) with each treatment combination consisting of 3 replications. The first factor is the position of the seeds on the cob (P) which consists of: p_1 = Position of seeds at the base of the cob; p_2 = Position of seeds in the middle of the cob; and p_3 = Position of seeds at the tip of the cob. The second factor is the comparison of the ratio of male to female parents (R) with 3 treatments, namely: r_1 = Parent ratio of 1 male line: 2 female lines; r_2 = Parent ratio of 1 male line: 3 female lines; and r_3 = Parent ratio of 1 male line: 4 female lines. The third factor is the application of *Trichoderma* sp. (T) with 3 treatments, namely: t_0 = Without *Trichoderma sp.* (control); t_1 = *Trichoderma* sp. with a density of 10^4 /ml water; and t_2 = *Trichoderma* sp. with a density of 10^8 /ml water.

There were twenty seven treatment combinations for each component and each treatment combination was repeated three times to obtain eighty one experimental units.

Handling Corn in the Garden

After the hybrid corn was planted from the parent ratio comparison treatment and the application of *Trichoderma* sp. Physiologically ripe (the husks are 90% dry, the corn kernels don't make a mark when pressed with a fingernail, there is a black layer at the base of the kernels), then harvesting is carried out and then treatment is carried out in the following stages:

Drying

Drying is carried out in the sun to reduce the water content until it reaches a water content of 16% - 17% with the aim of minimizing damage due to shelling using machines.

Sorting Cobs

Sorting or selecting cobs is done manually before shelling, sorting is done to separate corn with small cobs and damaged ones.

Shelling

Shelling is done using a semi-mechanical corn sheller machine to separate 1/5 of the base of the kernel, 3/5 of the middle and 1/5 of the tip.

Cleaning

Cleaning is done using a paktampa with the help of wind to separate dirt and seeds that are broken during shelling.

Water Content after Piping

Corn moisture content is measured from shelled corn kernels. Water content testing was carried out on corn seeds using a *seed moisture tester* until an average water content of 14% was obtained.

Research Sampling (Seeds)

The seeds used as research subjects were seeds that had been dried and shelled and classified into three parts, namely base, middle and tip in each treatment, each requiring 0.5 kg of seeds.

Seed Testing

Seed quality testing includes a viability test represented by a germination test. Testing vigor for growth strength uses the variables growth speed, growth simultaneity, primary root length, sprout length, number of secondary roots, and normal sprout dry weight.

The germination test was carried out using paper rolled in plastic (UKD $_p$) with CD plano paper growing medium. Germinator temperature and humidity measurements are carried out periodically. The humidity of the media was maintained by watering on the second day and after each observation. Germination capacity was tested with three replications of 50 seeds in each treatment. Sprouts are categorized as normal sprouts if the shoot and root sizes are proportional, have seminal roots, and there are no damaged structures. Shoot length, primary root length, number of secondary roots and dry weight of normal sprouts were tested at the last observation.

Observation Parameters

Germination Power (DB)

Germination capacity was calculated based on the comparison of the number of normal sprouts at 3 days after and 6 days after planting with the total number of seeds germinated. Observations were made on the basis of sprout criteria, namely: normal, namely the plumule and roots develop well; abnormal, namely empty coleoptiles, or weak root development, and/or weak small plumules; and death is when the seeds rot or do not develop.

Growth Speed (K_{CT})

Data obtained from testing seed germination. Each time an observation is made, the percentage of normal sprouts is divided by the etmal (24 hours). The cumulative etmal value is obtained from the time the seeds were planted until the last observation time of 6 days after planting. Calculation of growth speed with the Formula 1.

$$KT = \sum \frac{X_i - X_{(i-1)}}{T_i} \quad (1)$$

Information:

KT = Growth speed (% etmal $^{-1}$)

X $_i$ = Percentage of normal sprouts at observation i

T $_i$ = Observation time (per etmal, where 1 etmal = 24 hours)

Simultaneity of Growth (K_{ST})

Simultaneity of growth is the growth of seeds homogeneously, germinating simultaneously, and realizing uniform sprout performance. Simultaneous observations grew on the days between, between the first observation on day 3 and the second observation, namely day 6.

$$K_{ST} = \frac{Normal\ sprouts\ between\ days\ I\ and\ II}{Sprouting\ Seeds} x 100\% \quad (2)$$

Normal Sprout Dry Weight (BKKN)

The sprouts obtained from the seed growth test after being planted for 6 days were dried in the oven at a temperature of 60 ^{o}C for 3 x 24 hours. After that, the dried sprouts were put into a desiccator and after they had cooled, the weight was weighed. The dry weight of sprouts was calculated from the total dry weight divided by the number of sprouts.

Electrical Conductivity (DHL) µmhos g $^{-1}$ cm $^{-2}$

Electrical conductivity was observed using a Methron E 38 type conductometer. 5 g of seeds were taken randomly, each soaked in ion-free water for 24 hours with a water volume of 50 ml in a 100 milliliter beaker, then measured on a conductometer. As a blank, ion-free water was used which was also stored in a beaker for 24 hours.

Long Sprouts (PK)

Plumule length measurements were carried out on ten normal sprouts on the 6th day after planting, selected randomly. Measurement of plumule length starts from the base of the plumule to the tip of the growing point.

Primary Root Length (PAP)

Primary root length measurements were carried out on ten normal seedlings on the 6th day after planting, selected randomly. The length of the primary root is measured from the base of the root to the tip of the primary root.

Number of Secondary Roots (JAS)

Secondary root counting was carried out on ten normal seedlings on the 6th day after planting, selected randomly. The secondary roots counted are all secondary roots that grow on the sprout, whether in normal condition or not, intact or broken.

Results and Discussion

Results

Germination Power (DB)

The observation results for the normal sprout percentage parameters in observing the germination of corn seeds and their variance are presented in appendix tables 1a and 1b. The variance print shows that seed position, parent ratio, *Trichoderma* sp., interaction of seed position and *Trichoderma* sp., interaction of parent ratio and *Trichoderma* sp. and the interaction of the three had no significant effect, while the interaction of seed position and parental ratio had a significant effect on seed germination. For more details, the percentage of normal sprouts can be seen in Table 1.

Based on further tests in table 1, it shows that the combination of base seed position treatment and parent ratio of 1:3 (p1r2) produces the best average percentage of normal sprouts of 99.33%, which is significantly different from the combination of base seed position treatment and parent ratio of 1: 2 (p1r1) and middle seed position and ratio 1:3 (p2r2), but not significantly different from the combination treatment of base seed position and parent ratio 1:4 (p1r3), tip seed position and parent ratio 1:3 (p3r2).

Table 1. Average Percentage of Normal Germination (%) of Corn Plant Seeds

Ratio	Seed position			NP BNT
	p1	p2	p3	(pr)
r1	95.11 $^{b}{}_{y}$	98.44 $^{a}{}_{x}$	97.11 $^{a}{}_{x}$	2.580
r2	99.33 $^{a}{}_{x}$	96.67 $^{a}{}_{y}$	96.89 $^{a}{}_{x}$	
r3	98.22 $^{a}{}_{x}$	96.89 $^{a}{}_{x}$	96.89 $^{a}{}_{x}$	

Note: Values followed by the same letter in columns (a, b) and rows (x, y) mean that they are not significantly different at the BNT test level $_{\alpha= 0.05}$

Growth Speed (K_{CT})

The observation results for the parameters of the speed of growth of corn seeds and their variances are presented in appendix tables 2a and 2b. The variance prints show that seed position, parent ratio, *Trichoderma* sp., interaction of seed position and parent ratio, interaction of seed position and *Trichoderma* sp., interaction between parental ratio and *Trichoderma* sp . and the interaction of the three has no significant effect on the speed of seed growth. For more details, the speed of seed growth can be seen in Figure 1.

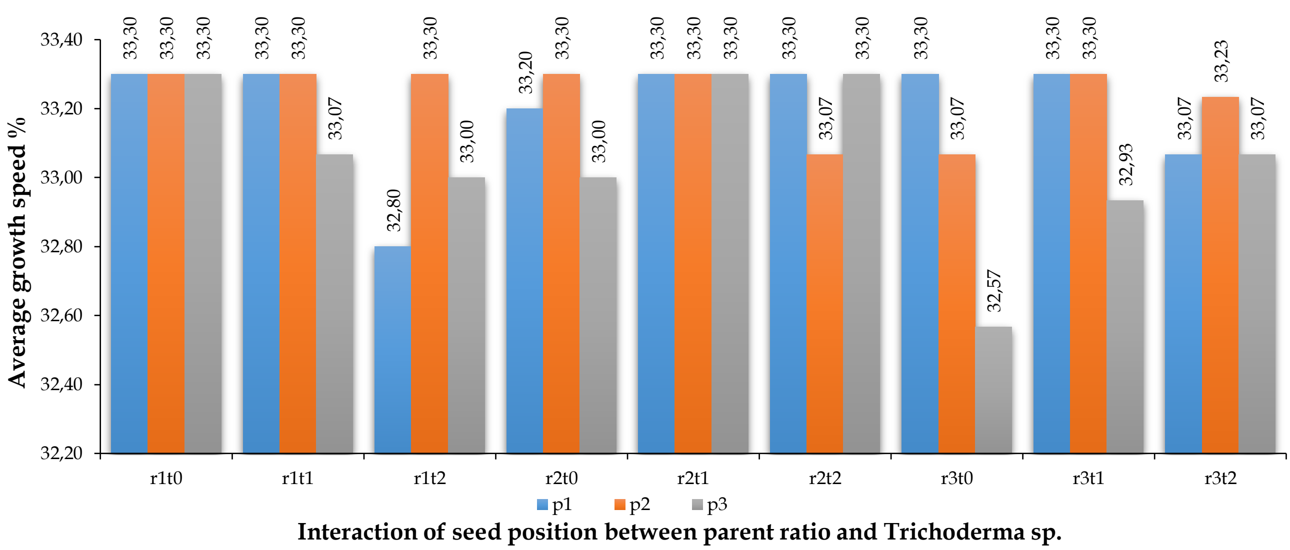

Figure 1. Average speed of growth of corn seeds based on the interaction of seed position, parental ratio and *Trichoderma* sp.

Figure 1 shows that the average growth rate of corn seeds in the treatment combinations p1r1t0, p1r2t1, $p_1r_2t_1$, $p_1r_2t_2$, $p_1r_3t_0$, $p_1r_3t_1$, $p_2r_1t_0$, $p_2r_1t_1$, $p_2r_1t_2$, $p_2r_2t_0$, $p_2r_2t_1$, $p_2r_3t_1$, $p_3r_1t_0$, $p_3r_2t_1$, and $p_3r_2t_2$ gives an average -more average high at 33.30%. While the average value was lower in the combination treatment of tip seed position, parent ratio of 1:4 and no *Trichoderma* sp. (p3r3t0) of 32.57%.

Simultaneity of Growth (K_{ST})

The observation results for the parameters Simultaneity of growth of corn seeds and their variance are presented in appendix tables 3a and 3b. The variance print shows that the position of the seeds, the ratio of parents, *Trichoderma* sp., interaction of seed position and parental ratio, interaction of seed position and *Trichoderma* sp., interaction between parent ratio and *Trichoderma* sp. and the interaction of the three has no significant effect on the synchronization of seed growth. For more details, the synchronization of seed growth can be seen in Figure 2.

Based on Figure 2, it shows that the average simultaneous growth of corn seeds in the treatment combinations is p1r1t0, p1r2t1, p1r2t0, p1r2t1, p1r2t2, p1r3t0, p1r3t1, p2r1t0, p2r1t1, p2r1t2, p2r2t0, p2r2t1, p2r3t1, p2r3t2, p3r1 t0, p3r2t1, p3r2t2, and p3r3t0 gave a higher average of 100.00%, while the average value was lower in the treatment combination of base seed position, 1:2 parent ratio and *Trichoderma* sp. 10^8 (p1r1t2) of 98.67%.

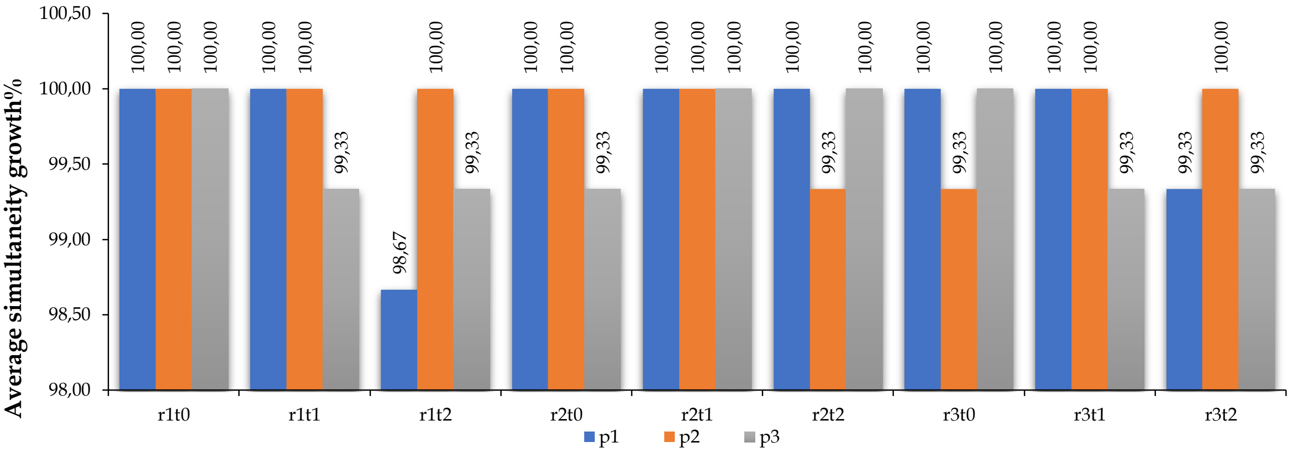

Figure 2. Average simultaneous growth of corn plant seeds on the interaction of seed position, parental ratio and *Trichoderma* sp.

Normal Sprout Dry Weight (BKKN)

Observation results for the dry weight parameters of corn seed sprouts and their variances are presented in appendix tables 4a and 4b. The variance prints show that seed position, the interaction of seed position and parent ratio, the interaction of seed position and *Trichoderma* sp., the interaction of parent ratio and *Trichoderma* sp . very real effect. The interaction of the three has a real effect. Meanwhile, the ratio of parents and *Trichoderma* sp . had no significant effect on the dry weight of the sprouts. For more details, the dry weight of normal sprouts can be seen in table 2:

Table 2. Average Dry Weight of Normal Sprouts (g) of Corn Seeds

Ratio/*Trichoderma* sp.		Seed position			NP BNT (rt)
		p1	p2	p3	
	t0	11.58 $^{d}_{y}$	12.81 $^{bc}_{x}$	11.17 $^{bc}_{y}$	0.632
r1	t1	10.22 $^{f}_{y}$	13.12 $^{b}_{x}$	9.15 $^{e}_{z}$	
	t2	10.80 $^{e}_{z}$	12.63 $^{c}_{x}$	11.68 $^{a}_{y}$	
	t0	11.59 $^{d}_{x}$	11.47 $^{e}_{x}$	11.68 $^{a}_{x}$	
r2	t1	13.25 $^{a}_{x}$	13.80 $^{a}_{x}$	10.12 $^{d}_{y}$	
	t2	12.02 $^{c}_{x}$	11.18 $^{e}_{y}$	10.21 $^{d}_{z}$	
	t0	12.68 $^{b}_{x}$	11.97 $^{d}_{y}$	11.20 $^{b}_{z}$	
r3	t1	13.26 $^{a}_{x}$	11.74 $^{de}_{y}$	10.83 $^{c}_{z}$	
	t2	12.00 $^{c}_{x}$	12.04 $^{d}_{x}$	10.11 $^{d}_{y}$	
NP BNT (p)				0.365	

Note: Values followed by the same letter in columns (a, b, c, d, e, f) and rows (x, y, z) mean that they are not significantly different at the BNT test level $\alpha = 0.05$

Based on further tests in Table 2, it shows that the combination of middle seed position treatment, parent ratio of 1:3 and *Trichoderma* sp. 10^4 (p2r2t1) produced an average dry weight of the heaviest normal sprouts of 13.80 g, which was significantly different from other treatment combinations except for the position of the base seeds, parent ratio of 1:3 and *Trichoderma* sp. 10^4 (p1r2t1).

Electrical Conductivity (DHL)

The observation results for the parameters of the electrical conductivity of corn seeds and their variance are presented in Appendix Tables 5a and 5b. The variance print shows that the position of the seeds and *Trichoderma* sp. very real effect. Parental ratio, interaction of seed position and parent ratio, interaction of seed position and *Trichoderma* sp. no real effect. Meanwhile, the interaction between parent ratio and *Trichoderma* sp . has a significant effect on electrical conductivity. For more details, electrical conductivity can be seen in Table 3.

Based on further tests in table 3, it shows that the combination of treatment with a parental ratio of 1:2 and without *Trichoderma* sp. (r1t0) produced the best average electrical conductivity of seeds of 12.37 μmhos g^{-1} cm^{-2}, not significantly different from the combination of 1:2 parental ratio treatment and *Trichoderma* sp. 10^4 (r1t1), but significantly different from the combination of treatment with a parental ratio of 1:2 and *Trichoderma* sp. 10^8 (r1t2), a parental ratio of 1:3 and without *Trichoderma* sp. (r2t0), parent ratio 1:4 and no *Trichoderma* sp. (r3t0).

Table 3. Average Electrical Conductivity (*μmhos* $^{-1}$ cm^{-2}) of Corn Plant Seeds

Tricho derma sp.	Ratio			NP BNT
	r1	r2	r3	(rt)
t0	12.37 $^{a}{}_{x}$	9.13 $^{b}{}_{y}$	9.36 $^{b}{}_{y}$	
t1	11.72 $^{a}{}_{x}$	11.62 $^{a}{}_{x}$	11.50 $^{a}{}_{x}$	1.894
t2	8.97 $^{b}{}_{x}$	10.46 $^{ab}{}_{x}$	9.24 $^{b}{}_{x}$	

Note: Values followed by the same letter in columns (a, b) and rows (x, y) mean that they are not significantly different at the BNT test level $_{\alpha = 0.05}$

Sprout Length (PK)

The observation results for the parameters of the length of sprouts of corn seeds and their variance are presented in appendix tables 6a and 6b. The variance print shows that seed position, parental ratio and the interaction of seed position and *Trichoderma* sp. very real effect. *Trichoderma* sp., and the interaction between seed position and parent ratio had no significant effect. Meanwhile, the interaction between the ratio of parents and *Trichoderma* sp ., and the interaction of the three significant effect on sprout length. For more details, the length of the sprouts can be seen in table 4.

Table 4. Average Length of Sprouts (cm) of Corn Seeds

Ratio/ *Trichoderma* sp.		Seed position			NP BNT
		p1	p2	p3	(rt)
r1	t0	10.23 $^{f}{}_{x}$	10.22 $^{c}{}_{x}$	10.02 $^{d}{}_{x}$	0.681
	t1	12.44 $^{b}{}_{x}$	10.93 $^{b}{}_{y}$	10.28 $^{cd}{}_{y}$	
	t2	11.45 $^{d}{}_{x}$	11.28 $^{b}{}_{x}$	10.98 $^{b}{}_{x}$	
r2	t0	11.06 $^{e}{}_{y}$	11.76 $^{a}{}_{x}$	10.98 $^{b}{}_{y}$	
	t1	12.57 $^{b}{}_{x}$	11.88 $^{a}{}_{y}$	9.93 $^{d}{}_{z}$	
	t2	13.15 $^{a}{}_{x}$	10.51 $^{c}{}_{z}$	11.79 $^{a}{}_{y}$	
r3	t0	11.42 $^{de}{}_{x}$	9.37 $^{e}{}_{y}$	10.80 $^{BC}{}_{x}$	
	t1	11.88 $^{c}{}_{x}$	9.90 $^{d}{}_{y}$	8.73 $^{e}{}_{x}$	
	t2	10.52 $^{f}{}_{x}$	9.55 $^{de}{}_{x}$	10.43 $^{c}{}_{y}$	
NP BNT (p)				0.393	

Note: Values followed by the same letter in columns (a, b, c, d, e, f) and rows (x, y, z) mean that they are not significantly different at the BNT test level $_{\alpha = 0.05}$

Based on further tests in table 4, it shows that the combination of treatment of base seed position, parent ratio of 1:3 and *Trichoderma* sp.10^8 (p1r2t2) produced an average length of the longest sprout of 13.15 cm, significantly different from other treatment combinations.

Primary Root Length (PAP)

Observation results for the parameters of primary root length of corn seeds and their variances are presented in appendix tables 7a and 7b. The variance prints show that seed position, parent ratio, *Trichoderma* sp., interaction of seed position and parent ratio, interaction of seed position and *Trichoderma* sp., interaction ratio of parents and *Trichoderma* sp. and the interaction of the three had no significant effect on primary root length. For more details, the length of the primary roots of seeds can be seen in Figure 3.

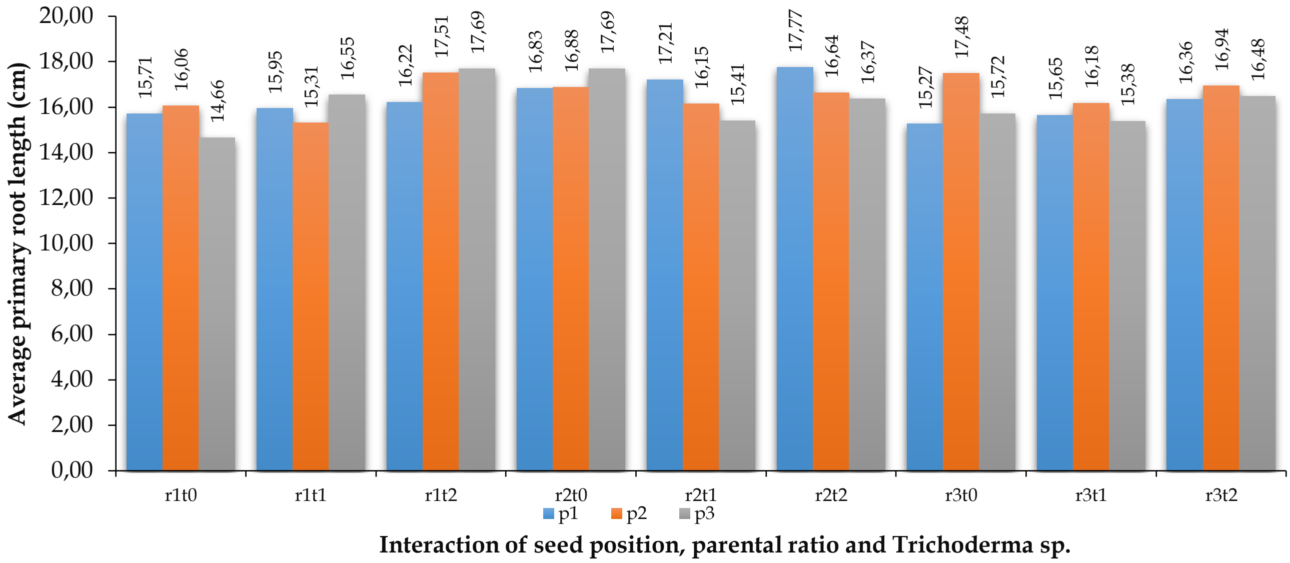

Figure 3. Average length of primary roots of corn seedlings in the interaction of seed position, parental ratio and *Trichoderma* sp.

Based on Figure 3, it shows that the average root length of corn seeds in the treatment combination of base seed position, parent ratio of 1:3 and *Trichoderma* sp. 10^8 (p1r2t2) gives a longer average of 17.77 cm. while the average value was shorter in the treatment combination of base seed position, parent ratio of 1:2 and no *Trichoderma* sp . (p1r1t0) is 14.66 cm.

Number of Secondary Roots (JAS)

The observation results for the parameter Number of secondary roots of corn seeds and their variance are presented in appendix tables 8a and 8b. The variance print shows that the position of the seeds, the ratio of parents, the interaction of the position of the seeds on the cob with *Trichoderma* sp., interaction of parental ratio with *Trichoderma* sp. and the interaction of the three has a very real effect. *Trichoderma* sp. no real effect. Meanwhile, the interaction of seed position and parental ratio had a significant effect on the number of secondary roots for more details on the number of secondary roots, see Table 5.

Table 5. Average Number of Secondary Roots of Corn Plant Seeds

Ratio/ *Trichoderma* sp.		Seed position			NP BNT
		p1	p2	p3	(rt)
r1	t0	4.30^{e}_{x}	4.00^{c}_{y}	4.17^{cd}_{xy}	0.240
	t1	4.40^{de}_{xy}	4.60^{a}_{x}	4.17^{cd}_{y}	
	t2	5.60^{a}_{x}	4.53^{a}_{y}	4.43^{b}_{y}	
r2	t0	3.97^{f}_{y}	4.13^{c}_{y}	4.43^{b}_{x}	
	t1	4.67^{c}_{x}	3.70^{d}_{z}	4.10^{d}_{y}	
	t2	4.47^{d}_{x}	4.30^{b}_{y}	4.00^{de}_{x}	
r3	t0	4.20^{e}_{y}	4.00^{c}_{y}	4.80^{a}_{x}	
	t1	5.43^{b}_{x}	3.73^{d}_{y}	3.83^{e}_{y}	
	t2	3.60^{g}_{y}	3.80^{d}_{y}	4.27^{c}_{x}	
NP BNT (p)				0.139	

Note: Values followed by the same letter in columns (a, b, c, d, e, f, g) and rows (x, y, z) mean that they are not significantly different at the BNT test level $_{\alpha = 0.05}$

Based on further tests in able 5, it shows that the combination of treatment of base seed position, parent ratio of 1:2 and *Trichoderma* sp. 10^8 (p1r1t2) produced the highest average number of secondary roots of 5.60, significantly different from other treatment combinations.

Discussion

Quality seeds are a determining factor in the economic success of planting. Seed quality testing is a very important part of seed production, it is an activity to assess the quality of a seed. Known the position of the seeds on the cob, the comparison of the parent ratio and the application of *Trichoderma* sp. can improve the quality of corn seeds.

Effect of Seed Position on the Cob on the Quality of Hybrid Corn Seeds

Based on the research results, it shows that testing seeds at the base of the cob gave the best results on the parameters of sprout length and number of secondary roots and the middle part of the cob gave the best results on the parameters of normal sprout dry weight, electrical conductivity on the quality of hybrid corn seeds. This is in accordance with Adie et al. (2019) statement in his research that the position of the seeds on the corn cob influences the viability of the corn seeds.

Differences in the quality of corn seeds at various seed positions on the cob are influenced by seed size. Based on measuring the weight of 100 corn seeds, it shows that the seeds in the middle of the cob have the largest weight, namely 15.24 g, the base of the cob is 15.10 g, and the tip of the cob is 12.73 g. If you look at the morphology, the seeds in the middle of the cob are large flat, round and irregular at the base of the cob, and small round at the tip of the cob.

Corn kernels consist of three main parts, namely the pericarp, in the form of a thin outer layer, which functions to prevent the embryo from intruding organisms and losing water; endosperm, as a food reserve, reaches 75% of the seed weight which contains 90% starch and 10% mineral protein, oil, etc.; and embryo (institution) (Subekti, 2010). Meanwhile, corn kernels in the middle of the cob have a larger endosperm size compared to the tip and base of the cob, so they have higher seed viability.

The difference in size is associated with the content of food reserves and the size of the embryo. According to Schmidt (2000) seed size sometimes correlates with seed viability and vigor, where heavier seeds tend to have better vigor.

Effect of Parental Ratio on Hybrid Corn Seed Quality

Based on the research results, it shows that testing seeds at a parent ratio of 1:2 gives the best results on the number of secondary roots parameter and a parent ratio of 1:3 gives the best results on the parameter length of secondary roots on the quality of hybrid corn seeds. This is in accordance with Yuyun et al. (2017) statement that the ratio of male to female parents influences the quality of corn seeds.

Plant pollen management is important to ensure the availability of pollen in order to increase the production and quality of hybrid corn seeds. If the planting of the male parent is too low, the female parent will lack pollen so that many cobs will be toothless, therefore it is necessary to regulate the composition of the male and female rows to obtain optimal seed yields (Fadhilah, 2020; Yuyun & Syaban, 2017).

In corn plantings, before harvesting, the male elders are pruned so that it can affect the light intensity during the ripening process of the corn seeds, thereby affecting the quality of the seed yield. Where the factors that influence the quality of seed results can be classified into genetic factors and agro-ecological factors, while the factors that influence the genetic quality component are: the situation of the production land, whether it is a plant adaptation area or not; and the level of security against genetic contamination, whether isolation, *roguing* or equipment cleanliness is adequate or not. And agro-ecological factors that influence the physical and/or physiological quality of seeds are: quality of source seeds; soil fertility and moisture; environmental weather conditions; harvest methods; time of harvest; and seed diseases (Mugnisjah et al., 1990).

Effect of Application of Trichoderma sp. on the Quality of Hybrid Corn Seeds

Based on the research results, it shows that testing seeds in the application of *Trichoderma* sp. 10^8 gave the best results on the electrical conductivity parameter on the quality of hybrid corn seeds. This is in accordance with the statement of Sumadi et al. (2015) Seed coating with *Trichoderma* sp. able to produce high quality seeds, both germination capacity and vigor index which are close to the maximum number (10).

Trichoderma sp soaking application . on the seeds before planting will influence the growth and resistance of the plant to disease so that the seeds produced are of good quality. *Trichoderma* sp . is an antagonistic agent that plays a role in inhibiting the growth of several plant pathogenic fungi. The advantages of the fungus *Trichoderma* sp . in control mechanisms that are target specific and capable of improving seed quality in terms of plant resistance.

According to research by Sutama et al. (2015), the application of *Trichoderma* sp. can reduce the occurrence of downy mildew in NK22 hybrid corn plants. *Trichoderma* sp. reported in several studies for its effectiveness in suppressing the development of the pathogen *Fusarium* sp. which causes rotting of corn stems, cobs and kernels (Suriani et al., 2016).

Interaction of Seed Position on the Cob with Parental Ratio, Interaction of Seed Position on the Cob with the Application of *Trichoderma* sp., Interaction of Parental Ratio with Application of *Trichoderma* sp., Interaction Between Seed Position on the Cob, Comparison of Parental Ratio and Application of *Trichoderma* sp . Regarding the Quality of Hybrid Corn Seeds.

Interaction of Seed Position on the Cob with Parental Ratio

Based on the results of the research, it shows that in testing seed quality, the interaction of middle seed position and parent ratio of 1:2 gave the best results on the parameter dry weight of normal sprouts, the interaction of base seed position and parent ratio of 1:2 gave the best results on the parameter number of secondary roots, the interaction of seed base position and parent ratio of 1:3 gave the best results on germination parameters. This shows that the interaction between seed base position and parent ratio of 1:3 still has high viability. According to Sadjad et al. (1999) and Suryanti et al. (2024) states that seed viability is the vitality of the seed which can be demonstrated through metabolic symptoms or growth symptoms. In general, seed viability is defined as the ability of the seed to grow into sprouts.

Interaction of Seed Position on the Cob with Application of Trichoderma sp.

Based on the research results, it shows that in testing seed quality, the interaction between middle seed position and *Trichoderma* sp. 10^4 gave the best results on normal sprout dry weight parameters, and the interaction of seed base position and *Trichoderma* sp. 10^4 gave the best results on the parameters of number of secondary roots and length of sprouts. With the interaction of base position and *Trichoderma* sp. 10^4, able to support seed viability. Seeds with high viability will produce strong seedlings with rapid root development resulting in healthy plantings (Finch-Savage & Bassel, 2016).

Interaction of Parental Ratio with Application of Trichoderma sp.

Based on the research results, it shows that in testing seed quality, the interaction between the parent ratio of 1:3 and *Trichoderma* sp. 10^4 gave the best results on normal sprout dry weight parameters, parent ratio interaction of 1:3 and *Trichoderma* sp. 10^8 gave the best results on the parameters of sprout length, parent ratio interaction of 1:2 and *Trichoderma* sp. 10^8 gave the best results on the parameters of number of secondary roots and electrical conductivity. Electrical conductivity means that the higher the level of cell membrane leakage, the lower the physiological quality of the seeds. According to Endang et al. (2001), seed soaking water contains several organic and inorganic exudates.

Interaction Between Seed Position on the Cob, Comparison of Parent Ratio and Application of Trichoderma sp.

Based on the research results, it shows that the interaction of the three factors in testing seed quality, the interaction of seed base position, parent ratio 1:3 and *Trichoderma* sp. 10^8 gave the best results on the parameters of sprout length, on the interaction of seed base position, parental ratio of 1:2 and *Trichoderma* sp. 10^8 gave the best results on the parameters of the number of secondary roots, the interaction of middle seed position, parental ratio of 1:3 and *Trichoderma* sp. 10^4 gave the best results for normal sprout dry weight parameters.

The high dry weight of the sprouts on the interaction of seed position, parental ratio of 1:3 and *Trichoderma* sp. 10^4 shows that the sprouts are still classified as vigor because they are still able to form a complete sprout morphological structure so that they have high biomass. This is in accordance with Sushkevich et al. (2020) statement that the dry weight of sprouts is closely related to the vigor of the sprouts.

Differences in seed viability at various positions of the seeds on the cob are influenced by the size of the seeds, the base and middle positions of the seeds have a larger size compared to the seeds at the tip of the cob. In the ratio comparison, it is influenced by the maturity level of the seeds, parent ratios of 1:2 and 1:3 have a better level of maturity than the parent ratio of 1:4, and the application of soaking *Trichoderma* sp. on seeds before planting influences plant growth and resistance to disease so that the seeds produced have good quality *Trichoderma* sp. 10^4 and *Trichoderma* sp. 10^8 better than without *Trichoderma* sp.

The research results show that the interaction of seed position, parent ratio and *Trichoderma* sp. does not affect the parameters of germination, vigor index, seed growth speed, seed growth synchronization, electrical conductivity, and primary root length, because seeds that have not been stored (still new) with optimal water content are able to carry out the germination process well thereby reducing the number of seeds which does not grow because the new seeds have not undergone major metabolic changes (Toubiana et al., 2012). According to Rajjou et al. (2008), metabolic changes occur as the seeds get older and the ability of the seeds to germinate also decreases.

Conclusion

The base seed position gave the best results with a sprout length of 11.63 cm and a number of secondary roots of 4.51. The middle seed position gave the best results with a normal sprout dry weight of 12.31 g and an electrical conductivity of 8.19 ($\mu mhos^{-1}$ cm^{-2}) on the quality of hybrid corn seeds. The parental ratio of 1:2 gave the best results at a secondary root number of 4.47. The parental ratio of 1:3 gave the best results at a primary root length of 16.84 cm on the quality of hybrid corn seeds. Application of *Trichoderma* sp. a density of 10^8 /ml water gives the best results with an electrical conductivity of 9.56 ($\mu mhosg^{-1}$ cm^{-2}) on the quality of hybrid corn seeds. The interaction of middle seed position with a parent ratio of 1:2 gave the best results at a normal dry weight of 12.85 g of sprouts. The interaction of base seed position with a parental ratio of 1:2 gave the best results at a number of secondary roots of 4.77. The interaction of base seed position and parent ratio of 1:3 gave the best results with a germination capacity of 99.33% on the quality of hybrid corn seeds. There is an interaction between the position of the middle seed and *Trichoderma* sp. a density of 10^{4} /ml water gives the best results at a normal dry weight of 12.89g of sprouts. Interaction of seed base position with *Trichoderma* sp. density of 10^4 /ml water gave the best results with a number of secondary roots of 4.83 and a sprout length of 12.29 cm on the quality of hybrid corn seeds. Interaction of 1:3 parent ratio with *Trichoderma* sp. a density of 10^{4} /ml water gave the best results at a normal dry weight of 12.39g of sprouts. Interaction of 1:3 parent ratio with *Trichoderma* sp. a density of 10^8/ml water gave the best results at a sprout length of 11.82 cm. Interaction of 1:2 parent ratio with *Trichoderma* sp. a density of 10^8 /ml water gave the best results with a secondary root number of I4.86 and an electrical conductivity of 8.97 ($\mu mhos g^{-1}$ cm^{-2}) on the quality of hybrid corn seeds. Interaction between seed base position, parental ratio of 1:2 and *Trichoderma* sp. a density of 10^{8} /ml water gave the best results at a number of secondary roots of 5.60. Interaction of seed base position, parent ratio 1:3 and *Trichoderma* sp. a density of 10^{8} /ml water gives the best results at a sprout length of 13.15 cm. Interaction of middle seed position , parent ratio 1:3 and *Trichoderma* sp . a density of 10^{4} /ml water gave the best results at a normal sprout dry weight of 13.80 g on the quality of hybrid corn seeds.

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References

Adie, M. M., Krisnawati, A., & Hapsari, R. T. (2019). The effect of seed position in pod on the seed viability of cowpea (Vigna unguiculata). *Biosaintifika: Journal of Biology & Biology Education*, *11*(1), 68–76. https://doi.org/10.15294/biosaintifika.v11i1.1773 0

Aisah, A. R., & Hipi, A. (2021). Morphological characteristics and resistance to the pest of local corn variety of "Jago Leke" genetic resources in West Nusa Tenggara. *IOP Conference Series: Earth and Environmental Science*, *911*(1), 12008. https://doi.org/10.1088/1755-1315/911/1/012008

Alizah, M. N., & Rum, M. (2020). Kinerja pemasaran dan strategi pengembangan jagung hibrida unggul madura MH-3 di Kabupaten Bangkalan. *Agriscience*, *1*(2), 448–463. https://doi.org/10.21107/agriscience.v1i2.8177

Darmali, Y. (2010). *Penentuan Komposisi Tanaman Induk Jantan dan Betina Terhadap Produktivitas dan Vigor Benih F1 Jagung Hibrida Bima-5*. Retrieved from https://adoc.pub/penentuan-komposisi-tanaman-induk-jantan-dan-betina-terhadap.html

Endang, T. S., Yudono, P., & Indradewa, D. (2001). Viability test of stored corn seeds based on the relationship between concentration of inorganic exudates and electrical conductivity of soaking water. *Ilmu Pertanian (Agricultural Science)*, *8*(2). Retrieved from https://journal.ugm.ac.id/jip/article/download/59976/29311

Fadhilah, A. N. (2020). *Produksi Benih Jagung Sinhas 1 Melalui Rasio Jantan-Betina dan Teknik Pemangkasan* [Universitas Hasanuddin]. Retrieved from https://repository.unhas.ac.id/id/eprint/366/2/G011171306_skripsi_12-11-2020%28FILEminimizer%29_1-2.pdf

Finch-Savage, W. E., & Bassel, G. W. (2016). Seed vigour and crop establishment: extending performance beyond adaptation. *Journal of Experimental Botany*, *67*(3), 567–591. https://doi.org/10.1093/jxb/erv490

Firdaus, M. W., & Fauziyah, E. (2020). Efisiensi Ekonomi Usahatani Jagung Hibrida di Pulau Madura. *Agriscience*, *1*(1), 74–87. Retrieved from https://journal.trunojoyo.ac.id/agriscience/article/view/7624

Fozilov, G. G., Arifin, A. S., Khudaev, I., Yuldashev, B., & Igamberdiev, R. (2021). Comparing industrial grain and seed for sowing of corn in the conditions of Uzbekistan. *IOP Conference Series: Earth and Environmental Science*, *868*(1), 12051. https://doi.org/10.1088/1755-1315/868/1/012051

Gunawan, A., Wulandari, E., & Suminartika, E. (2022). Efektivitas pelaksanaan program bantuan benih jagung hibrida di Kecamatan Nagreg Kabupaten Bandung. *Jurnal Agrinika: Jurnal Agroteknologi Dan Agribisnis*, *6*(2), 161–175. https://doi.org/10.30737/agrinika.v6i2.2140

Jiao, Y., Chen, H.-D., Han, H., & Chang, Y. (2022). Development and utilization of corn processing by-products: a review. *Foods*, *11*(22), 3709. https://doi.org/10.3390/foods11223709

Lapui, A. R., Nopriani, U., & Mongi, H. (2021). Analisis Kandungan Nutrisi Tepung Jagung (Zea mays Lam) dari desa uedele kecamatan tojo kabupaten tojo una-una untuk pakan ternak. *Agropet*, *18*(2), 42–46. Retrieved from https://ojs.unsimar.ac.id/index.php/AgroPet/article/view/359

Ngawit, I. K., Yakop, U. M., & others. (2022). Uji Efektivitas Beberapa Jenis Tanaman Penutup Tanah (Ground Cover) Terhadap Gulma Jagung (Zea mays L.). *Jurnal Ilmiah Mahasiswa Agrokomplek*, *1*(3), 182–191. https://doi.org/10.29303/jima.v1i3.1456

Rajjou, L., & Debeaujon, I. (2008). Seed longevity: survival and maintenance of high germination ability of dry seeds. *Comptes Rendus Biologies*, *331*(10), 796–805. https://doi.org/10.1016/j.crvi.2008.07.021

Rizkika, A. B. (2023). *Strategi Pengembangan Wilayah Melalui Pengembangan Komoditas Tanaman Jagung di Desa Martopuro, Kecamatan Purwosari, Kabupaten Pasuruan*. [Institut Teknologi Sepuluh Nopember]. Retrieved from https://repository.its.ac.id/101706/

Sadjad, S., Murniati, E., & Ilyas, S. (1999). *Parameter pengujian vigor benih dari komparatif ke simulatif* (Vol. 185). Jakarta: Grasindo.

Schlegel, R. H. J. (2009). *Dictionary of plant breeding*. CRC Press.

Shurson, G. C. (2020). “What a waste”—can we improve sustainability of food animal production systems by recycling food waste streams into animal feed in an era of health, climate, and economic crises? *Sustainability*, *12*(17), 7071. https://doi.org/10.3390/su12177071

Suryanti, E., Chusniasih, D., Istiadi, K. A., Anisa, H. A. N., & others. (2024). Improving Viability and Vigor of Corn (Zea mays) Seeds using Bio-priming. *Selected Papers of International Conference on Health, Science, and Environment (ICHSE 2023)*, 103–112. https://doi.org/10.2991/978-94-6463-431-0_12

Sushkevich, N. I., Zabegaeva, O. N., Burlyaeva, M. O., & others. (2020). The effect of growing conditions and the year of reproduction on sowing qualities of seeds, morphological and physiological characteristics in sprouts of Vigna radiata (L.) R. Wilczek. *Proceedings on Applied Botany, Genetics and Breeding*, *181*(2), 73–86. https://doi.org/10.30901/2227-8834-2020-2-73-86

Taqiuddin, M., Fachry, A., & Nachida, M. (2023). Analisis Kinerja Ekonomi Sub-Sektor Peternakan Dalam Pembangunan Daerah Nusa Tenggara Barat Periode 2008-2018. *Journal of Classroom Action Research*, *5*(1). https://doi.org/10.29303/jcar.v5i1.3472

Toubiana, D., Semel, Y., Tohge, T., Beleggia, R., Cattivelli, L., Rosental, L., Nikoloski, Z., Zamir, D., Fernie, A. R., & Fait, A. (2012). Metabolic profiling of a mapping population exposes new insights in the regulation of seed metabolism and seed, fruit, and plant relations. *PLoS Genetics*, *8*(3), e1002612. https://doi.org/10.1371/journal.pgen.1002612

Warisno. (2013). *Hybrid Corn Cultivation*. Yogyakarta: Kanisius.

Yélamo Mayorga, J. (2021). *Global potential of bioethanol production from biowaste* [Universitat Politècnica de Catalunya]. Retrieved from http://hdl.handle.net/2117/358878

Yuyun, I., & Syaban, R. A. (2017). Rasio Tanaman Induk Jantan dan Betina serta Penambahan Pupuk Boron pada Tanaman Jantan terhadap Produksi dan Mutu Benih Jagung Manis (Zea mays “saccharata” Sturt.). *Agriprima, Journal of Applied Agricultural Sciences*, *1*(1), 1–11. https://doi.org/10.25047/agriprima.v1i1.17