



SINHAS-1 Maize Seed Production Through Male-Female Ratio and Pruning Technique

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Abstract

The research was aimed to obtain male and female rows ratio and best pruning technique towards SINHAS 1 maize production. This research was conducted in Experimental Farm Faculty of Agriculture, Hasanuddin University, Tamalanrea District, Makassar, South Sulawesi with elevation of 22,4 meters above the sea level throughout May – August 2020. The experiment was carried out in the form of Split Plot Design with male-female row ratio as main plot, which consisted of three levels: 1:2 ratio, 1:3 ratio, and 1:4 ratio. Sub plot was pruning techniques: no pruning, male parent pruning and leaf pruning under the cob of female parent. The result showed that the favorable male-female row ratio towards SINHAS 1 maize production was 1:4 ratio. Male parent pruning was the best pruning technique for SINHAS 1 maize production. The interaction between male-female ratio and best pruning technique was 1:3 male-female ratio with male parent pruning technique. Characters that showed positively direct significance towards productivity were cob diameter, cob length, and number of seed rows per cob

Keywords: pruning, ratio, SINHAS 1, yield

A. Introduction

Maize is one of the most significant crops worldwide used as food, fodder, vitamin source and industrial base material. Maize has a strategic role in national economy, including Indonesia. Increasing population growth will correlate with the ever-increasing crop demands. Therefore, yearly maize production is nowadays crucial (Panikkai, Nurmalina, Mulatsih, & Purwati, 2017).

Over the last five years, maize production in Indonesia had increased moderately. The production of maize in 2018 (30.055.623 t) showed 3,91% growth from the year 2017 (28.924.009 t). Yet, the production increase was only caused by the additional harvest width of 3,64% with only 0,27% production growth from 5,23 t.ha⁻¹ (2017) to 5,24 t.ha⁻¹ (2018). Low maize productivity compared to its yield potential caused unmet national maize needs, which led to increased maize import from 2017 (714.504 t) to 2018 (2.300.450 t). Maize productivity increase became an important scope in national maize production fulfillment (Deptan, 2019).

Low maize production predominantly caused by cultivation environments that situated in marginal or stressed lands, especially drought stress and low nitrogen. Drought and low nitrogen tolerant varieties was an alternative solution to the problem mentioned. Unhas Synthetic maize variety (SINHAS 1) is a maize variety adaptive in drought and low nitrogen stress (Farid, Musa, Jamil, Ridwan, Pati & Nursini, 2020).

The variety performance was proved with its productivity in drought condition, reached \pm 6,27 t ha⁻¹ and \pm 6,41 t ha⁻¹ in low nitrogen stress. Furthermore, maize production under drought and low nitrogen stress combination was \pm 4,75 t ha⁻¹ (Farid, *et. al.*, 2020). Seed production was an inseparable factor in SINHAS 1 variety development. Consequently, utilization of SINHAS 1 maize variety can be imposed as solution in marginal lands.

Seed is a primary factor determining agriculture success, for this reason quality seed provision is an important component. Adequate number of quality seeds fulfillment can be attempted throughout Breeder Seed purity maintainance. Yet, various issues encountered in the seed production process. This can be caused by limited amount of pollen and husks, minimal number of kernels per cob, and low seed production. Appropriate solution is required in order to optimalize the seed production (Yuyun & Rahmat, 2017).

Male and female row ratio holds a keyrole in maize seed production. Male parent row is placed between female parent row. Minimal planting of male parents caused inadequate amount of pollen produced for female parent thus making an emptied cob. On the other hand, suitable male-female row ratio is needed to optimize seed production. A small number of male parent with enough pollen available for pollination is an optimal method in seed production. For this reason, plant pollen management is essential in mantaining pollen availability towards seed production and quality (Yuyun & Rahmat, 2017).

Sun energy radiation absorbtion and interception is another strategy attempted in increasing maize production, creating optimal condition, which can be done through pruning. Pruning is disposal of certain parts of the plant to get certain changes for the plant. Pruning aims to control size and shape of the plant, accelerate and strengthen plant growth as well as increasing productivity in terms of both quality and quantity (Herlina & Widya, 2017). Photosynthesis

potential of the leaves on 1/3 part of the plant is twice as more than 1/3 of leaves in the middle part of the plant and five times as much than 1/3 part of the leaves on the bottom of the plant (Permanasari & Kastono, 2012). Therefore, leaf pruning after pollination was expected to increase maize seed production. This research was aimed to determine the male-female row ratio settings and the application of suitable pruning technique in maize crops.

B. Methodology

This research was conducted in Experimental Farm, Faculty of Agriculture, Hasanuddin University, Tamalanrea District, Makassar, South Sulawesi on the elevation of 22,4 m above sea level throughout May-August 2020.

This research was designed under Split Plot Design with male-female row ratio as main plot and pruning techniques as sub plot. Male-female row ratio consisted of three levels: 1:2 ratio (R1), 1:3 (R2), and 1:4 (R3). Sub plot also consisted of three levels: no pruning (P0), male parent pruning (P1) and leaf pruning under the cob of female parent (P3). Overall treatment combination was replicated three times, thus resulting 27 experimental units. Plot width of each experimental unit depended on male-female ratio, yet each ratio was replicated twice in every unit. The plot width of 1 : 2, 1 : 3 and 1 : 4 male-female ratio was 3,5 m x 12,6 m, 3,5 m x 16,8 m and 3,5 m x 21 m respectively.

Path analysis was calculated according to simultan equation with formula as follows:

$$\begin{matrix} \begin{pmatrix} R_{11} & R_{12} & \dots & R_{1p} \\ R_{21} & R_{22} & \dots & R_{2p} \\ \dots & \dots & \dots & \dots \\ R_{p1} & R_{p2} & \dots & R_{pp} \end{pmatrix} & \begin{pmatrix} C_1 \\ C_2 \\ \dots \\ C_p \end{pmatrix} = \begin{pmatrix} R_{1y} \\ R_{2y} \\ \dots \\ R_{py} \end{pmatrix} \\ R_x & C & R_y \end{matrix}$$

Based on this equation, C value (direct effect) can be calculated with following formula

$$C = R_x^{-1} x R_y$$

Note : R_x = Corelation matrix between free variable;

R_x^{-1} = R_x Inverse matrix

C = Path coefficient vector which indicated direct effect from each standarized free variable towards dependent variable.

R_y = Corelation coefficient vector towards X_i variable with dependent variable.

Parameters observed in this research was weight of cob without corn husk (g), cob diameter (cm), cob length (cm), number of kernel rows per cob, seed rendement (%), 1000 seed weight (g) and productivity (ton ha⁻¹).

C. Result

Weight of cob without corn husk

Least significance difference test shown in table 1 indicates that male parent pruning (P1) gave the best weight of cob without corn husk with male-female ratio 1:2 (R1) with average of 220.85 g and was not significantly different with no pruning treatment (P0) and pruning of leaf below cob (P2). 1:3 male-female ratio (R2) and male parent pruning (P1) presented a better weight averaging in 235.76 g, which was not significantly different with no pruning treatment (P0) and pruning of leaf below cob (P2). 1:4 male-female ratio (R3) and pruning of leaf below cob (P2) gave better weight of cob without corn husk, averaging 263.24 g and significantly different with no pruning treatment (P0) and male parent pruning (P1).

Table 1. Weight of cob without corn husk (g) pruning techniques on varied male-female ratio

Pruning Technique	Male-Female Ratio			Average	NP (R) BNT 0.05
	R1	R2	R3		
P0	198.37 ^a _x	205.12 ^a _x	208.45 ^a _y	203.98	
P1	220.85^a_x	235.76^a_x	224.50 ^a _y	227.04	28.42
P2	203.82 ^b _x	213.60 ^b _x	263.24^a_x	226.89	
Average	207.68	218.16	232.06		
NP (P) BNT 0.05		30.75			

Note: Numbers followed by the same letter (a, b) in the same column (x,y,z) are not significantly different from the comparison variety based LSD0.05 test.

Cob Diameter

Least significance difference test shown in table 2 indicates that male parent pruning (P1) gave the best cob diameter with male-female ratio 1:2 (R1) with average of 46.55 mm and was significantly different with no pruning treatment (P0) and pruning of leaf below cob (P2). 1:3 male-female ratio (R2) and male parent pruning (P1) presented a better diameter averaging in 47.69 mm, which was not significantly different with pruning of leaf below cob (P2) and significantly different with no pruning treatment (P0). 1:4 male-female ratio (R3) and pruning of leaf below cob (P2) gave better diameter, averaging 48.50 mm and not significantly different with no pruning treatment (P0) and male parent pruning (P1).

Table 2. Cob Diameter (mm) pruning techniques on varied male-female ratio

Pruning Techniques	Ratio			Average	NP (R) BNT 0.05
	R1	R2	R3		
P0	41.67 ^b _y	44.75 ^{ab} _y	46.66 ^a _x	44.36	
P1	46.55^a_x	47.69^a_x	46.96 ^a _x	47.07	2.40
P2	42.67 ^b _y	46.62 ^{ab} _x	48.50^a_x	45.93	
Average	43.63	46.35	47.37		
NP (P) BNT 0.05		2.11			

Note: Numbers followed by the same letter (a, b) in the same column (x,y,z) are not

1000 Seed Weight

Least significance difference test shown in table 3 indicates that male parent pruning (P1) gave the best 1000 seed weight with male-female ratio 1:2 (R1) with average of 411.97 g and was significantly different with no pruning treatment (P0) and pruning of leaf below cob (P2). 1:3 male-female ratio (R2) and male parent pruning (P1) presented a better weight averaging in 421.95 g, which was significantly different with pruning treatment (P0) and pruning of leaf below cob (P2). 1:4 male-female ratio (R3) and pruning of leaf below cob (P2) gave better weight of 1000 seeds, averaging 426.50 g and not significantly different with no pruning treatment (P0) and male parent pruning (P1).

Table 3. 1000 Seed Weight (g)pruning techniques on varied male-female ratio

Pruning Techniques	Ratio			Average	NP (R) BNT 0.05
	R1	R2	R3		
P0	322.70 ^b _z	342.48 ^b _z	396.07 ^a _x	353.75	
P1	411.97^a_x	421.95^a_x	415.87 ^a _x	416.59	34.30
P2	368.73 ^b _y	382.57 ^b _y	426.50^a_x	392.60	
Rata-rata	367.80	382.33	412.81		
NP (P) BNT 0.05		31.16			

Note: Numbers followed by the same letter (a, b) in the same column (x,y,z) are not significantly different from the comparison variety based LSD0.05 test.

Cob Length

Least significance difference test shown in table 5 indicates that male parent pruning (P1) gave the best cob length with male-female ratio 1:2 (R1) with average 17.82 cm and was significantly different with no pruning treatment (P0) and pruning of leaf below cob (P2). 1:3 male-female ratio (R2) and male parent pruning (P1) presented a better length averaging in 19.53 cm, which was significantly different with pruning treatment (P0) and pruning of leaf below cob (P2). 1:4 male-female ratio (R3) and pruning of leaf below cob (P2) gave better length of cob, averaging 20.38 cm and not significantly different with no pruning treatment (P0) and male parent pruning (P1).

Table 4. Cob Length (cm) pruning techniques on varied male-female ratio

Pruning Techniques	Ratio			Average Rata	NP (R) BNT 0.05
	R1	R2	R3		
P0	15.77 ^b _y	16.53 ^a _y	18.07 ^a _x	16.79	
P1	17.82^a_x	19.53^a_x	19.40 ^a _x	18.92	1.81
P2	16.20 ^b _y	17.09 ^b _y	20.38^a_x	17.89	
Rata-rata	16.60	17.72	19.28		
NP (P) BNT 0.05			1.34		

Note: Numbers followed by the same letter (a, b) in the same column (x,y,z) are not significantly different from the comparison variety based LSD0.05 test

Number of Seed Rows Per Cob

Least significance difference test shown in table 4 indicates that male-female ratio 1:4 (R3) gave the best number of seed rows per cob with average 15.51 and was not significantly different with 1:3 male-female ratio (R2) and significantly different with male-female ratio 1:2 (R1). The best pruning technique was pruning of leaf below cob (P2) averaging in 15.01, which was not significantly different with pruning of leaf below cob (P2) and significantly different with no pruning treatment (P0).

Table 5. Number of seed rows per Cob in pruning techniques on varied male-female ratio

Pruning Techniques	Ratio			Average	NP (R) BNT 0.05
	R1	R2	R3		
P0	12.57	14.30	14.90	13.92 y	
P1	13.40	15.20	16.43	15.01 x	1.29
P2	13.77	15.43	15.20	14.80 x	
Rata-rata	13.24 b	14.98 a	15.51 a	14.58	
NP (P) BNT 0.05		0.71			

Note : Numbers followed by the same letter (a, b) in the same column (x,y,z) are not significantly different from the comparison variety based LSD0.05 test.

Seed Rendement

Least significance difference test shown in table 6 indicates that male parent pruning (P1) gave the best seed rendement with male-female ratio 1:2 (R1) with average 75.06 % which was not significantly different with pruning of leaf below cob (P2) and significantly different with no pruning treatment (P0). 1:3 male-female ratio (R2) and male parent pruning (P1) presented a better rendement averaging in 76.96%, which was not significantly different with pruning treatment (P0) and significantly different with pruning of leaf below cob (P2). 1:4 male-female ratio (R3) and pruning of leaf below cob (P2) gave better seed rendement, averaging 83.48% and not significantly different with no pruning treatment (P0) and male parent pruning (P1).

Table 6. Seed Rendement(%) pruning techniques on varied male-female ratio

Pruning Techniques	Ratio			Average Rata	NP (R) BNT 0.05
	R1	R2	R3		
P0	66.53 ^b _y	72.68 ^a _{xy}	69.34 ^a _y	69.51	
P1	75.06^a_x	76.96^a_x	80.89 ^a _x	77.64	5.19
P2	69.18 ^b _{xy}	70.32 ^b _y	83.48^a_x	73.83	
Rata-rata	70.26	73.32	77.90	73.83	
NP (P) BNT 0.05		5.94			

Note: Numbers followed by the same letter (a, b) in the same column (x,y,z) are not significantly different from the comparison variety based LSD0.05 test.

Productivity

Least significance difference test shown in table 7 indicates that male parent pruning (P1) gave the best productivity with male-female ratio 1:2 (R1) with average 3.78 t ha-1 which was significantly different with no pruning treatment (P0) and pruning of leaf below cob (P2). 1:3 male-female ratio (R2) and male parent pruning (P1) presented a better productivity averaging

in 4.37 t ha⁻¹ which was significantly different with pruning treatment (P0) and pruning of leaf below cob (P2). 1:4 male-female ratio (R3) and pruning of leaf below cob (P2) gave better production, averaging 4.39 t ha⁻¹ and significantly different with no pruning treatment (P0) and male parent pruning (P1).

Table 7. Productivity (t ha⁻¹) pruning techniques on varied male-female ratio

Pruning Techniques	Ratio			Average Rata	NP (R) BNT 0.05
	R1	R2	R3		
P0	3.44 ^b _y	3.70 ^a _y	3.95 ^a _y	3.70	
P1	3.78^b_x	4.37^a_x	4.25 ^a _x	4.13	0.32
P2	3.44 ^b _y	3.98 ^b _y	4.39^a_x	3.94	
Rata-rata	3.55	4.02	4.20	3.92	
NP (P) BNT 0.05		0.29			

Note: Numbers followed by the same letter (a, b) in the same column (x,y,z) are not significantly different from the comparison variety based LSD0.05 test.

Path Analysis

Table 8 indicates that the characters showing direct positive effect towards productivity were cob length without corn husk (CW) (0.21), cob diameter (CD)(0.29), cob length (CL) (0.66) and number of seed rows per cob (NR) (0.29), whilst the negatively direct influenced characters were seed rendement (R) (-0.17) and 1000 seed weight (1000 W) (-0.23). Character that exhibited highest direct influence value was cob length (0.66) meanwhile the lowest was derived from 1000 seed weight (-0.23). Indirectly influenced characters which showed highest value was cob length (2.83) and the lowest from 1000 seed weight (-0.92).

Table 8. Path Analysis of characters significantly corelated towards productivity.

Characters	Direct Effect	Residual						
		CW	CD	CL	NR	R	1000 W	
CW	0.21		0.23	0.59	0.14	-0.15	-0.18	0.03
CD	0.29	0.16		0.59	0.21	-0.13	-0.2	0.03
CL	0.66	0.19	0.26		0.2	-0.15	-0.21	0.03
NR	0.29	0.1	0.22	0.47		-0.11	-0.15	0.03
R	-0.17	0.18	0.22	0.59	0.18		-0.18	0.03
1000 W	-0.23	0.16	0.26	0.59	0.19	-0.13		0.03
Total		0.79	1.19	2.83	0.92	-0.67	-0.92	

Note : *R² = 82.94%

D. Discussion

From overall variance analysis, male-female ratio and pruning techniques gave significant and highly significant influence upon weight cob without corn husk, cob diameter, 1000 seed weight, cob length, number of seed rows per cob and seed rendement. The found result was supported by similar research by. Pratama & Purnamaningsih (2019), where male-female ratio gave significant influence towards productivity-supporting characters such as early cob weight, fresh tressed weight, dry tressed weight, number of kernels per cob and comparison percentage of seed and cob. Pruning treatment gave significant effect towards cob length, cob circumference, cob weight, number of seed rows per cob and number of seed per row and gave higher values compared to those without pruning. Thus, it is necessary to conduct further analysis of the male-female ratio and pruning tecniques.

High productivity was indicated by 1:4 male-female ratio (R3) with 4,20 t ha⁻¹. The average result was aligned with the supporting characters, namely cob weight without husk (232,06 g), cob diameter (47,37 mm), 1000 seed weight (412,81 g), cob length (19,28 cm), number of seed rows per cob (15.51) and seed rendement (77.90%). Based on the result, 1:4 male-female ratio was considered more efficient compared to 1:2 and 1:3 male-female ratio. According to Thomison (2002), 4:1 ratio (4 rows of female parent for 1 row of male parent), 4:2 ratio (4 rows of female parent for 2 rows of male parent), 4:1:4:2 ratio (4 female rows for 1 male row and 4 female rows for 2 males alternative) and 6:2 ratio (6 rows of female and 2 rows of male). However, Fadhly, Saenong, Arief, Tabri, Saenong, & Koes (2010) suggested that 1:4 ratio

presented best seed quality and production value of 1.32 t ha^{-1} . For this reason, 1:4 male-female ratio can be recommended in SINHAS 1 seed production.

1:4 male-female ratio (R3) was deemed to have more effective pollinating space than of other ratios. Seed production are mainly done with detasseling in order to avoid self pollination in maize. The moderate width of detasseling on 1:4 male-female ratio resulted more effective pollination due to precision of pollen dispersing angle not limited by the close proximity of male and female flower. Detasseling also increasing assimilation towards the cob in female parents. Therefore, productivity from 1:4 female ratio was preferred than 1:2 or 1:3 ratio. This was supported by Chamecki, Gleicher, Dufault, & Isard (2011), arguing that one of the factors affecting pollen dispersal patterns was the presence of barrier plants where the height, width and compactness of the plant can influence the wind speed as the primary factor of pollen dispersal.

High productivity was also presented by male parent pruning technique (P1) with value of 4.13 t ha^{-1} . Average productivity were obtained along with supporting characters: cob weight without corn husk (226.89 g), cob diameter (47.07 mm), 1000 seed weight (416.59 g), cob length (18.92 g), number of seed rows per cob (15.01) and seed rendement (77.64%).

Male parent pruning (P1) resulted an empty row between female rows group, causing the planting pattern appeared to be similar with *jajar legowo* planting pattern and for the instance, sun radiation absorption and water storage became more optimal. This was aligned with Rahmansyah, Bayu, & Sudiarso (2018), stating that productivity can be increased through *jajar legowo* planting pattern due to the effects of side plants which are expected to give high production and better grain quality. Furthermore, it can also increase cob width in maize and population per hectare in rice, empty space for water management, increasing sun radiation absorbtion which is beneficial in maize production.

Male pruning technique (P1) in the likings of *jajar legowo* planting system is able to maximize sun radiation intake by plants used for photosynthesis and for increasing cob weight and diameter, where increased number and weight of kernels will be resulting in increased cob weight and diameter. This was supported by Rahimi, Zuhry & Nurbaiti (2013), stating that seed weight is influenced by dry materials in the seeds. Thus, male pruning (P1) became the recommended pruning technique in SINHAS 1 seed production.

Interaction between male-female ratio and pruning techniques with best productivity value was found in 1:4 male-female ratio and pruning of leaf below female row cob (R3P2) with 4.39 t ha^{-1} . Interaction between 1:4 male-female ratio and pruning of leaf below female row cob (R3P2) significantly influenced other characters: weight of cob wihtout husk (263.24 g), cob diameter (48.50 mm), 1000 seed weight (426.50 g), cob length (20.38 cm), and seed rendement (83.48%).

Pruning of leaf below female parent cob (P2) was the preferred pruning technique followed by male pruning (P1). Pruning of leaf below female parent cob was carried out in order to increasing seed filling assimilate due to the photosynthetically inactive aging leaves below the cob. This condition was supported by Sugito (2009), stating that the position of aged leaves in the bottom part of the canopy causes reduced sun radiation intensity and photosynthesis and for supporting them, carbohydrate supply from other leaves was taken, therefore disadvantaging the respective plant. Photosynthetically inactive pruning resulted in larger transferred assimilate to the cob and with pruning such will leave more active leaves for photosynthesis purposes and increasing cob weight more than those without pruning (Zuchri, 2010). Pruning of leaf below cob also gives higher dry cob weight, dry threshing weight and 100 treshed seeds weight compared to without pruning (Surtinah, 2005).

Male-female ratio and pruning technique treatment towards productivity correlated significantly upon other characters. However, it is necessary for the correlations to be detected in order to determine the main character from secondary analysis that highly influencing productivity. Therefore, another test was needed, which was path analysis towards characters which were corelated with productivity.

The goal of path analysis is to determine the direct and indirect effect between growth characters and seed production (Nasution, 2010). Path analysis can calculate crucially contributing characters in maize production (Abdulkhaleq & Tawfiq, 2014). The highest direct effect on productivity was cob length with highest path coefficient, 0.95, while the character that showed highest indirect effect was stem diameter, 0.95. Moderate value of indirect effect usually has moderate correlation value (Rachmawati, Kuswanto, Purnamaningsih, 2014).

E. Conclusion

Based on the conducted research, it can be concluded that:

1. Male-female ratio which gave highest productivity was 1:4 ratio, with average seed production of 4.20 ton ha⁻¹.
2. The pruning technique which presented highest productivity was male parent pruning with average seed production of 4.13 ton ha⁻¹.
3. Interaction of 1:2 and 1:3 male-female ratio was shown by male parent pruning with average seed production of 3.78 ton ha⁻¹ and 4.37 ton ha⁻¹, whilst the comparison of 1:4 male female ratio was indicated by pruning of leaf below cob of female parent with average seed production of 4.39 ton ha⁻¹.
4. Characters which correlated with productivity were stem diameter, cob height, cob weight without husk, cob diameter, cob length, number of seed rows per cob, seed rendement and 1000 sed weight, meanwhile the characters that shown significantly direct effect towards productivity were cob weight without husk, cob diameter, cob length, and number of seed rows per cob.

F. References

Abdulkhaleq, D.A & S.I. Tawfiq (2014). Correlation and Path Coefficient Analysis of Yield and Agronomic Characters Among Some Maize Genotypes and Their F1 Hybrids in Diallel Cros. *Journal of Zankoy Sulaiman – Part A, Special Issue 16* : 1-8

Chamecki,M., S.C. Gleicher, N.S. Dufault, & S.A. Isard. (2011). Diurnal Variation in Settling Velocity of Pollen Released From Maize and Consequences for Atmospheric Dispersion and Cross-Pollination. *Agricultural and Forest Meteorology*, 151 (2011): 1055-1065. Doi:10.1016/j.agrformet.2011.03.009.

Departemen Pertanian. (2019). <https://www.pertanian.go.id/> (diakses pada 5 April 2020).

Fadhlly, A.F., S. Saenong, R. Arief , F. Tabri, & F. Koes. (2010). *Perakitan Teknologi Produksi Benih Jagung Hibrida Berumur Sedang (90-100 hari, hasil benih F1>2 t/ha). Laporan Akhir Program Insentif Riset Terapan*. Maros: Balai Penelitian Tanaman Serealia. 67 hlm

Farid M, Y. Musa, H. Jamil, I. Ridwan, S. Pati & Nursini. (2020). *Pengembangan dan Hirilisasi Produk Jagung Sintetik Unhas (Sinhas 1) Dalam Pemenuhan Kebutuhan Benih dan Produksi Jagung Nasional*. Makassar: Penelitian Inovasi dan Pengembangan Unhas Pelaksanaan Tahun 2020

Herlina, N & F. Widya. (2017). Pengaruh Persentase Pemangkasan Daun dan Bunga Jantan terhadap Hasil Tanaman Jagung (*Zea Mays L.*). *Jurnal Biodjati*, 2 (2), hal. 115-125.

Nasution, M.A. (2010). Analisis Korelasi dan Sidik Lintas antara Karakter Morfologi dan Komponen Buah Tanaman Nenas (*Ananas comosus L. Merr.*). *Crop Agro*, 3(1):1-9

Panikkai, S., R. Nurmaliha, S. Mulatsih, & H. Purwati. (2017). Analisis Ketersediaan Jagung Nasional menuju Pencapaian Swasembada dengan Pendekatan Model Dinamik. *Jurnal Informatika Pertanian*, vol. 26 (1)

Permanasari, I & D. Kastono. (2012). Pertumbuhan Tumpangsari Jagung dan Kedelai pada Perbedaan Waktu Tanaman dan Pemangkasan Jagung. *Jurnal Agroteknologi*, vol. 3 (1): 13-20

Pratama, N. Abiyasa & S.L. Purnamaningsih. (2019). Pengaruh Rasio Baris Induk Jantan dan Betina Dua Varietas Jagung (*Zea mays L.*) terhadap Hasil dan Kualitas Benih Hibrida. *Jurnal Produksi Tanaman*, 7 (2): 346 – 353

Rachmawati, R.Y., Kuswanto, & S.L. Purnamaningsih. (2014). Uji Keseragaman dan Analisis Path Analysis Antara Karakter Agronomis dengan Hasil Pada 7 Genotipe Padi Hibrida Japonica. *Jurnal Produksi Tanaman* 2(4): 292-300

Rahimi, Z. E. Zuhry, & Nurbaiti. (2013). Pengaruh Jarak Tanam Terhadap Pertumbuhan dan Produksi Padi Sawah (*Oryza sativa L.*) Varietas Batang Piaman dengan Metode System of Rice Intensification (SRI) di Padang Marpoyan Pekanbaru. *Jurnal. Fakultas Pertanian. Universitas Riau*. Hal 7

Rahmansyah, Bayu & Sudiars. (2018). Pengaruh Teknik Jajar Legowo dan Berbagai Jarak Tanam pada Pertumbuhan dan Hasil Tanaman Jagung Bisi 16 (*Zea mays Identata*). *Jurnal Produksi Tanaman*, 6(6): 1012-1019

Sugito, Y. (2009). *Ekologi Pertanian*. Malang: UB Press

Surinah. (2005). Hubungan Pemangkasan Organ Bagian Atas Tanaman Jagung (*Zea mays L.*) dan Dosis Urea Terhadap Pengisian Biji. *Jurnal Ilmiah Pertanian*, 1(2).

Thomison P. (2002). *Cultural Practices for Optimizing Maize Seed Yields & Quality. Seed Production Seminar Oct. 15 and 16. 2002. Pontificia Universidad Catolica de Chile. Ohio: Horticulture and Crop Science*. Ohio State University

Yuyun, Indah & R.A. Syahban. (2017). *The Ratio of Male and Female Parental and Addition Boron Fertilizer in Male Plant to the Production and Quality Seed of Sweer Corn (Zea mays "saccharata" STURT. Agrip prima : Journal of Applied Agricultural Sciences*, 1 (1): 1-12

Zuchri, A. (2010). Dampak Penataan Baris Tanam dan Defoliasi Daun Jagung Terhadap Hasil Jagung (Varietas Tabin), Pertumbuhan dan Hasil Kacang Tanah (Varietas Jerapah) dalam Sistem Tumpangsari. *Agrovigor*. 3 (1) : 40-46