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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2018 15(2): 694-701. **OPEN ACCESS**

Direct and indirect selection of plant maturity component of some soybean genotypes resistant to leaf rust disease

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The increase of soybean production can be done by using superior variety which is resistant to diseases, highly productive and short-aged. The objectives of the research are to know the soybean genotype which is short-aged and to know the agronomic traits which greatly affect maturity age. The agronomic traits cover blooming age, plant height, number of branches, number of pods per plant, number of fertile nodes and weight of 100 seeds. This experiment was conducted on Experimental Field of Jember State Polytechnic. The experiment used RCBD (Randomized Complete Block Design) with 3 replications. Each replication consisted of 4 varieties (Dering, Rajabasa, Polije-2, Polije-3), 7 hybridization results (P2P3, P3R, P3D, P3P2, RD, P2R, P2D) with 2 comparers (Malabar and Ringgit). If there were different real results, further *Scott-Knott* test would be done. It will be continued by doing genotypic correlation analysis and path analysis to know the direct and indirect relationship among the agronomic traits on maturity age of the soybean pods. The result of further *Scott-Knott* test showed that short-aged characteristic was owned by Rajabasa and it was different unreal to Polije-2, Polije-2 x Rajabasa genotypes hybridization, Polije-2 x Dering, Polije-3 x Rajabasa, Polije-3 x Polije-2, and also the short-aged comparer of Malabar, they were 79.67 dap, 87.33 dap, 86 dap, 86 dap, 86 dap, 84.33 dap, and 83.67 dap. The result of path analysis showed that agronomic trait which could be used as the maturity age of pods selection criterion was the number of fertilenodes direct influence through the plant height and number of pods indirect influence.

Keywords: Soybean, Agronomic Traits, Maturity Age, Direct and Indirect selection

INTRODUCTION

Soybeans commonly can grow well and can produce optimally on profitable environments. On the other side, most of the consumers recently do not only like soybeans which have high production potential and big seeds but also soybeans with short-aged characteristic. The preference on short-aged soybeans is higher than the preference on deep-aged soybeans since they can increase cropping index.

The invention of superior varieties in which one of them is short-aged will be very helpful for farmers to fill cropping pattern with rice-rice-palawija.

The example of cropping pattern with short-aged variety is to plant soybean after harvesting rice in the end of wet season by using soil cultivation cropping pattern, so the remaining time of the wet season after the second rice harvesting still can be used to plant soybean. This thing is done by expecting that national soybean production can be increased (Arwin et al., 2012).

The effort to increase soybean production cannot be done just by using short-aged superior varieties but also by considering to the cropping locations. In Indonesia, the areas for cropping are various, so that cropping should be done on profitable environment to gain products optimally. However, if the condition of the environment was not really profitable, it would cause growth inhibition and the emergence of plant diseases, for instance leaf rust disease caused by *Phakopsora pachyrhizi*. Sumartini (2010) stated that leaf rust disease belongs to quick development diseases. The spores brought by wind, water and insects cause diseases that can spread into all parts, especially if it is supported by appropriate weather throughout the year, it will cause production losses. The production loss quantity depends on the resistance of every plant to leaf rust disease. According to Suryanto (2010), leaf rust disease attacks soybean plants at the age 0f 30-40 days after cultivated and it will cause production decrease in about 20%-80%. Therefore, short-aged varieties that resistant to leaf rust disease are importantly needed. Short-aged soybean variety cultivation is one of the endurance mechanisms to minimize the development of leaf rust disease since the period of pods filling is shorter.

Soybean varieties which are resistant to leaf rust disease and short-aged can be obtained from a breeder by doing hybridization of the expected genotypes and testing them by using pedigree selection method. According to Hartatik (2007), pedigree is a method that is commonly used in self-pollination plants selection and it has resulted in many productions with expected gen combination on the next generation. It is caused by pedigree selection is often done by humans so that from F2 generation until F8 generation have been selected by researchers.

MATERIALS AND METHODS

The research was conducted on Experimental Field of Jember State Polytechnique. The experiment was conducted in December 2015 to April 2016. The materials used in this experiment consist of: a) 7 genotypes of F5 seeds selected from F4 plant, they were genotype P2P3 (Polije2 x Polije3), RD (Rajabasa x Ringgit), P3R (Polije 3 x Rajabasa), P2R (Polije2 x Rajabasa), P3D (Polije3 x Dering), P2D (Polije2 x Dering), P3P2 (Polije3 x Polije2); b) 4 varieties, they were POLIJE-2 (P2), POLIJE-3(P3), Rajabasa (R) and Dering-1 (D); c) 1 variety comparer which is susceptive to leaf rust disease namely Ringgit (Ri); and d) 1 variety as the short-aged comparer namely Malabar (M).

This experiment used Randomized Block Design with 3 times replications in which each replication consisted of 13 experimental units (7 genotypes of hybridization, 4 genotypes of varieties, 2 genotypes of rust resistant and short-aged comparer). The size of each plot

was 200 cms x 100 cms with length of the space among the plots 50 cms and cropping space 40 cms x 20 cms. If it results in different real or different very real outcomes, *Scott-Knott* test will be done.

Path analysis is used for quantitative characters association by using genotypic correlation analysis and continued with path analysis. Genotypic correlation by Singh and Chaudhary (1979) is formulated as follows:

$$r_g (X_1 X_2) = \frac{Cov_g\ X_1 X_2}{\sqrt{\sigma^2_g\ (X_1).\sigma^2_g\ (X_2)}}$$

Notes:

rg (X1 X2) = Genotype correlation between trait X1 and X2

Covg. X1 X2 = Genotype variator between trait X1 and X2

(X_1) = Genotype variant trait X_1

(X_2) = Genotype variant trait X_2

Path analysis based on simulant equation uses formula as follows (Singh and Chaudhary, 1979):

$$\underset{A}{\begin{bmatrix} rx_1y \\ rx_2y \\ rx_3y \end{bmatrix}} = \underset{B}{\begin{bmatrix} rx_1x_1 & rx_1x_2 & rx_1x_3 \\ rx_2x_1 & rx_2x_2 & rx_2x_3 \\ rx_3x_1 & rx_3x_2 & rx_3x_3 \end{bmatrix}} \underset{C}{\begin{bmatrix} px_1y \\ px_2y \\ px_3y \end{bmatrix}}$$

or A = B.C. Based on above equation, value of C (direct influence) can be counted by using formula as follows:

C = B-1A

Notes:

B (matrix correlation among independent variables)

B^{-1} (matrix invers B)

C (matrix path coefficient that indicate direct influence on every independent variable standardized by dependent variables)

A (matrix correlation coefficient between independent variable Xi (i=1,2,....p) and dependent variable Y)

After calculating the value of direct influence (C), there will be a possibility to get residual value

(R). The influence of residu on Y (Pry) is calculated by using equation:

Pry = (1 - ∑ (PiY x Rij)}) 1/2
i=1

Singh dan Chaudary (1979) stated that the following requirements should be considered in drawing conclusion of path analysis:

If the correlation among variables is nearly the same as the direct influence, then the correlation explain the real relationship and direct selection through the variables will be effective.

If the correlation is positive while the direct influence is negative, then it is the indirect influence that causes the correlation. In this case, the variable that carries indirect influence should be concerned further.

If the correlation coefficient is negative but the direct influence is positive and the value is great, correct limitation should be done in this model. The limitation is needed to eliminate the influence of expected indirect variable in order to make the direct influence more useful.

RESULTS AND DISCUSSION

Variant Analysis of Some Agronomic Traits

Variant analysis is a method to analyze data in an experiment. Variant analysis is often used as one of the alternatives to draw variant conclusion of an object, for examples, some experiments in agriculture, farming, and other fields (Nurhasanah, 2012). The resume of variety coefficient and F-Count of some agronomic traits is presented in Table 1.

The different results of variety coefficient indicated the level of data accuracy on every agronomic trait, however, there was no criteria for value which was considered as true since the variety coefficient was greatly affected by many factors. The result of variant analysis showed that agronomic traits of some soybean genotypes investigated had different very real appearances. Yet, there was an agronomic trait that showed result different unreal on the number of branches. The content of Table 1 explained that there were appearance diversities of investigated agronomic traits and soybean genotypes. According to Hartatik (2007), the high diversity of plants contributes enormously to the success of plant breeding program.

The Result of *Scott-Knott* Test of Soybean

Agronomic Traits

The weaknesses of Duncan test are the incapability of resulting specific information and the difficulty in interpreting the result of the test. This is because the procedure of the test is done partially on every treatment so that there are so many results gained (Ismail, 2009). Therefore, the results that indicated different real and different very real were tested further by using *Scott-Knott* test. The calculation result of *Scott-Knott* test could be seen in Table 2**.**

The result of Scott-Knott test showed that different genotype will also show different appearance after interacting with a particular environment. According to Sumardi (2014), the differences of genetic traits will cause different responses of varieties in some environmental conditions, so that the results showed are different. Besides, a plant will experience physiological and morphorlogical changes to adapt to its new environment, so that different variety will show different growth and production even though it is cultivated on the same environment. The excellent trait of a genotype can be known from the interaction among its agronomic traits that linked to each other in showing their phenotypes. A plant which has good appearance, based on Arwin et al., (2012), is characterized by a plant which is sturdy, has strong stems and many pods, grows well and healthy, and also is resistant to diseases.

Correlation Analysis

Correlation analysis among the agronomic traits is used to reveal whether or variable Y. The level of correlation relationship can be seen based on the value interval, where 0.8-1.00 means very strong, 0.6-0.79 means strong.

The means genotypic correlation value of agronomic traits on maturity age of pods is presented in Table 3, 0.4-0.59 means quite strong, and 0.2-0.39 low.

Table 1. KK and F-Count Resume of Agronomic Traits

No	Observed Traits	KK	F-Count
1	Blooming Age (X_1) days	1.54%	9.766**
2	Plant Height (X_2) cms	9.09%	4.679**
3	Number of Branches (X_3)	11.59%	1.419ns
4	Number of Pods (X_4)	6.56%	5.850**
5	Number of Fertile Joints (X_5)	7.35%	5.452**
6	Weight of 100 Seeds/Plant (X_6) g	6.42%	16.730**
7	Maturity Age of Pods (X_7) days	5.22%	3.752**

Notes: (ns) non-significant different; (*)Significant different; (**) Highly significant different

Table 2. The Result of *Scott*-Knott Test of Soybean Agronomic Traits

Genotipe	X1	X2	X3	X4	X5	X6
R	38b	81	89b	13b	10a	80b
D	37c	68	87b	12b	9b	91a
P2	36c	69	87b	12b	9b	87b
P3	36c	92	89b	13b	9b	99a
RD	39a	85	67a	15a	7c	93a
P2R	37c	75	68b	13b	9b	86b
P2D	37c	72	66b	12b	9b	86b
P2P3	37c	69	65b	12b	9b	89b
P3D	38b	90	68b	15a	9b	94a
P3P2	37c	73	65b	12b	9b	84b
Ri	39a	92	72a	16a	5d	94a
M	37c	78	68b	13b	11a	84b

Notes: the number followed by the same letter in those colum showed non-significant different

X1	Blooming age	P2P3	Polije 2 x Polije 3	P2D	Polije 2 X Dering
X2	Plant Height	P3D	Polije 3 X Dering	R	Rajabasa
X3	Number of Pod	P3P2	Polije 3 x Polije 2	D	Deing
X4	Number of Fertile N.	RD	Rajabasa x Dering	P2	Poleje 2
X5	100 Seed Weight	Rri	Rajabasa x Ringgit	M	Malabar
X6	Maturety Age	P2R	Polije 2 x Rajabasa	Ri	Ringgit

Table 3. Genotypic Correlation Value of Agronomi Traits on Maturity Age of Pods

$r(x_1x_2)$	X1	X2	X3	X4	X5	X6	X7
X1	1.000**						
X2	0.651**	1.000**					
X3	0.626**	0.917**	1.000**				
X4	0.884**	0.827**	0.488**	1.000**			
X5	0.897**	0.895**	0.516**	1,000**	1.000**		
X6	-0.599ns	-0.561ns	0.187ns	-0.835**	-0.835**	1.000**	
X7	0.288ns	0.817**	0.595	0.708**	0.715**	-0.757**	1.000**

Notes: (ns) different unreal; (*) significantly different; (**) Highly Significantly different

Maturity age of pods is positively correlated very real to plant height, number of branches, number of pods, and number of fertile joints which means that the deeper the maturity age of pods the taller the plant height followed by the increase of number of branches, number of fertile joints, and number of pods. Based on Hapsari and Adie's research (2010), it is known that the longer the age of a plant will be followed by the increase of plant height, number of branches, and number of pods, so that the soybean production can be increased. Maturity age of pods is also positively correlated but different unreal on blooming age which means that maturity age of pods has low relationship on blooming age. However, number of pods is negatively correlated different unreal to weight of 100 seeds per plant which means that the deeper the maturity age of pods the lower the weight of 100 seeds per plant. This is caused by the deeper the age of the plants, their height will be taller so that the photosynthesis outcomes will be more used for the height increase and the outcomes for the pods will be decreased.

Path Analysis

Path diagram is used to know the interaction between one trait to another trait. From the path diagram result, it can be known about how big the direct and inderect influence is since each of the traits which are correlated to maturity age of pods can be parsed into direct and indirect influence. The magnitude of the direct and indirect influence will give easiness to whether or not the agronomic traits selection is effective on the maturity age of pods. The result of the path analysis is presented on the diagram picture as follows.

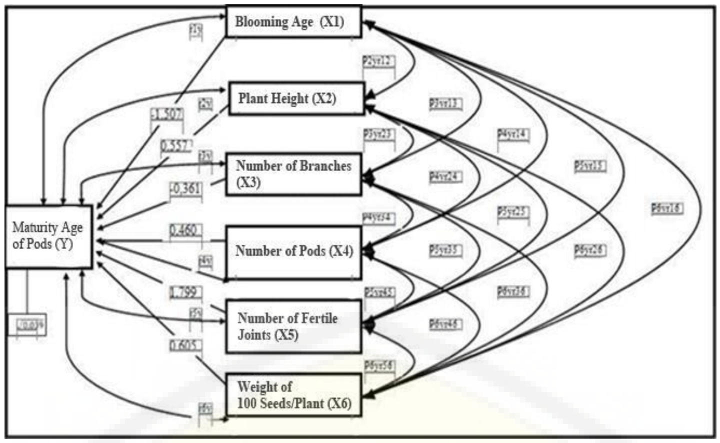
The magnitude of direct and indirect influence done in the research is presented in Table 4.

Table 4 showed that plant height, number of pods, and number of fertile joints have positive correlation value to maturity age of pods and the value of direct influence is also positive. It means that the agronomic traits explain that the real relationship and maturity age of pods through the plant height, the number of pods and the number of fertile joints would be more effective. (Asadi, Woerjono, and Harjo-sudarmo, 2004) in their research stated that in soybean plants case, plant height is closely related to plant age. The longer the plant age caused the taller the plant height which indicated that the more the photosynthate produced caused the more the number of fertile joints because of the more the number of pods also.

The agronomic traits of blooming age and number of branches have positive correlation value to maturity age of pods, those are 0.288 and 0.595, but the direct influence has negative value of -1.507 and -0.361. Therefore, it can be known that blooming age and number of branches are less effective if they are used as the selection guide of maturity age of pods but they should be concerned further in the indirect influence, the number of fertile joints.

The agronomic trait which has positive direct influence value and negative correlation value is the agronomic trait of weight of 100 seeds per plant. The weight of 100 seeds per plant has negative correlation to maturity age of pods with amount -0.575 and positive direct influence with amount 0.605. In the selection of maturity age of pods through weight of 100 seeds per plant limitation needed to be done. The limitation is done by limiting the indirect influences in order to make the direct influences more useful.

Table 5 showed that the highest total donation on full maturity age was on the number of fertile joints with amount 1.287. This trait also had positive correlation value and direct influence, with the biggest value among the others 0.715 and 1.799, so that the number of fertile joints was really effective to be used in the selection. Both of plant height and number of pods have positive correlation and direct influence and also have small total donation value of 0.455 and 0.326.



Picture 1. Path Diagram of Soybean Agronomic Traits

Table 4. Direct and Indirect Influence

Variabel	X1	X2	X3	X4	X5	X6	R(xiY)
X1	-1.507	0.362	-0.226	0.407	1.614	0.382	0.288
X2	-0,981	0.557	-0.410	0.381	1.610	0.330	0.817
X3	-0.943	0.633	-0.361	0.225	0.928	0.113	0.595
X4	-1.332	0.460	-0.176	0.460	1.799	0.504	0.708
X5	-1.352	0,498	0.498	0.460	1.799	0.505	0.715
X6	0.903	-0.312	-0.312	-0.383	-1,502	0.605	-0.957

Table 5. Correlation Resume on Maturity Age Pods (rxv). Direct Influence on Maturity Age of Pods (Pxy) and Total Donation of Agronomic Traits on Maturity Age of Pods.

No	Agronomic Traits	rxiy	Pxiy	Total Donation
1	Blooming Age (X1) days	0.288	-1.507	-0.434
2	Plant Height (X2) cm	0.817	0.557	0.455
3	Number of Branches (X3)	0.595	-0.361	-0.215
4	Number of Pods (X4)	0.708	0.460	0.326
5	Number of Fertile Nodes (X5)	0.715	1.799	1.287
6	100 Seeds Weight (X6) g	-0.757	0.605	-0.458
	Total			0,961
	Residu			$\sqrt{0{,}039}$
	Pry			0.039

It means that plant height and number of pods can be used for indirect selection on maturiry age of pods although their influences were smaller than their number of fertile joints. (Singh & Chaudhary, 1985) stated that in drawing conclusion of path analysis, if the direct influence of a certain characteristic and the correlation among the variables are positive then the direct selection through that character can be done effectively.

The total donation of path analysis of agronomic traits on full maturity age defined the amount of the residu. The value of residu gained was $\sqrt{0{,}039}$. The residu value explained that maturity age of pods was not only affected by direct and indirect influence of agronomic traits but also the other factors that could not be explained by using path analysis test, for instances climate, temperature, rainfall, *etc*. This residu value caused the value of total donation of agronomic traits on maturity age of pods decreased. According to (Junaedi, 2011), the lower the residu value the better the information would be obtained because most of the direct and indirect influences on maturity age of pods could be explained by the observed traits.

CONCLUSION

Based on the experiment results and discussion, it can be summarized that:
The research result of genotype which is short-aged was indicated by the shortest maturity age of pods of variety Rajabasa and was different unreal on Polije-2, genotype hybridization result of Polije-2 and Rajabasa, Polije-2 and Dering, Polije-3 and Rajabasa, Polije-3 and Polije-2, and also the short-aged comparer Malabar with days interval after cultivation for each 79.67 days after planting (dap), 87.33 dap, 86 dap, 86 dap, 86 dap, 84.33 dap and 83.67 dap. Agronomic traits that could be considered for direct selection on maturity age of pods of some soybean genotypes on F5 generation based on the path analysis was the number of fertile joints through the indirect influence of plant height and number of pods.

CONFLICT OF INTEREST

This study was conducted without any conflict of interest.

ACKNOWLEGEMENT

Thank you for the expenses incurred for KKP3 research from DEPTAN R.I.

AUTHOR CONTRIBUTIONS

Moh. Setyo Poerwoko designed his plant breeding program as a whole, Nurul Sjamsijah designed in Plant Garden & Laboratorium in plant Breeding.

REFERENCES

Akdon, S., & Hadi, S. (2005). *Aplikasi Statistika dan Metode Penelitian untuk Administrasi dan Manajemen*. Bandung: Dewa Ruchi.

Arwin, Mulyana, H. I., Tarmizi, Masrizal, Faozi, K., & Adie, M. (2012). Galur Mutan Harapan Kedelai Super Genjah Q-298 dan 4-Psj. *Jurnal Ilmiah Aplikasi Isotop Dan Radiasi*, *8*(2), 107–116. Retrieved from http://jurnal.batan.go.id/ index. php/jair/ article/view/504

Asadi, S., Woerjono, M., & Harjosudarmo, J. (2004). Effectiveness of bulk modification and pedigree selection methods for agronomic characters and resistance to soybean stunt virus (SSV) on F7 soybean lines yield. *Zuriat*, *5*(1), 64–76. Retrieved from http://agris. fao.org/agris.search/ search.do? recordID=ID2007000186

Hapsari, R. T., & Adie, M. M. (2010). Pendugaan parameter genetik dan hubungan antar komponen hasil kedelai. *Jurnal Penelitian Pertanian Tanaman Pangan*, *29*(1), 18–23. Retrieved from http:// pangan.litbang.pertanian.go.id/files/03-pp012010.pdf

Hartatik, S. (2007). *Pengantar Pemuliaan Tanaman*. Jember: Jember University Press. Retrieved from http://repository. unej.ac.id/ handle /123456789/ 103

Ismail, A. (2009). Rancangan Percobaan Metode Analisis Gerombol Scott-Knott. Jatinangor: Universitas Padjadjaran. Retrieved from https ://dokumen.tips/ documents/6c-contoh-kasus-scott-knott.html

Junaedi, W. (2011). *Uji daya hasil galur-galur generasi lanjut kacang tanah (Arachis Hypogaea L.) tahan penyakit bercak daun* (Skripsi). Institut Pertanian Bogor. Retrieved fromhttp://repository.ipb. ac.id/ handle/123456789/53362

Miftahorrachman. (2010). Korelasi dan Analisis Koefisien Lintas Karakter Tandan Bunga terhadap Buah Jadi Kelapa Genjah Salak. *Buletin Palma*, (38), 60–66. Retrieved from http:// ejurnal.litbang.pertanian.go.id/ index.php/palma/article/view/7138

Nurhasanah, D. (2012). *Pemeriksaan Asumsi Analisis Ragam* (Skripsi). Institut Pertanian Bogor. Retrieved from http://repository.ipb. ac.id/ handle/123456789/ 54638

Singh, R. K., & Chaudhary, B. D. (1985). *Biometrical Methods in Quantitative Genetics Analysis*. Kalyani Publishers. Retrieved from https:// books.google. co.id/ books?id= QQV3 tw AAAAJ

Sumardi. (2004). *Pertumbuhan dan Hasil Beberapa Varietas Kedelai (Glycine max L.) terhadap Jenis Pupuk Pelengkap Cair* (Skripsi). Universitas Tamansiswa. Retrieved from http://journal.unitaspdg.ac.id/downlotfilemh.php? file=jurnal Sumardi.pdf

Sumartini, S. (2010). Penyakit Karat pada Kedelai dan Cara Pengendaliannya yang Ramah Lingkungan. *Jurnal Penelitian dan Pengembangan Pertanian*, *29*(3),107–112.- Retrieved from http://e jurnal. Litbang.petanian.go.id/index.php/jppp/article/view/5690

Suryanto, W. A. (2015). *Hama dan Penyakit*. Yogyakarta: Kanisius.