Eberhard-Russel Test of Stability of Several Genotypes Segregation in Five Soybeans at Centra East of Java

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Eberhard-Russel Test of Stability of Several Genotypes Segregation in Five Soybeans at Centra East of Java

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Abstract. Soybean is an important plant because of its role as a source of vegetable protein. Candidates for new superior varieties G-1, G-2, G-3, G-4, G-5, UNEJ-1 and UNEJ-2 have a yield potential of ton 2.5 tons/ha and are of early maturity (<76 days) and has resistance to the main disease of soybeans, leaf rust disease.The study was conducted in April to November 2018 in five soybean centers in East Java, namely the experimental plant Research Institute for beans and tubers in Genteng, Muneng, Ngale, Kendalpayak, andPoliteknik Negeri Jember.The experimental design used for each location was a randomized block design with ten genotypes with three replications. The size of each plot of the experiment is 2.8 m x 4.5 m. The distance between rows is 40 cm and inside the rows are 15 cm. Each hole is filled with three seeds, and after growing two healthy plants are left behind. Next is the stability of the Eberhart and Russel method.The results of the analysis for seed weight per ha are as follows, for genotypes G-1, G-2, G-3, G-4 and G-5 and UNEJ-1 are stable in five locations, while UNEJ-2, Malabar and Ringgit apparently unstable.

1. Introduction

Soybean is an important crop because of its role as a source of vegetable protein and can be used as an industrial raw material. In Indonesia the results are still low so that every year imports need to be large enough to meet the national needs of [1]. Low soybean productivity and high production costs make domestic soybean production still very difficult to compensate for the increasing needs, even though by looking at the existing potential of production it is still possible to be increased. This research was conducted on the basis of the results of previous studies conducted by) where the two lines produced namely Unej 1 and Unej 2 have high production advantages with a potential yield of three tons per hectare. Four cross yields (Trisusilowati*et al.* (2009) hybridnamely Malabar with UNEJ-1 and UNEJ-2 were tested using selection in segregation generation the beginning of the generation of F2 segregation. Malabar variety as a donor for age characterflowering (R1) and maturity of harvest (R8) are selected based on the collection of plasmanutfah Research Institute for Nuts and Tubers (Balitkabi, 2005). While the two elders who have adapted well in East Java agroecology and have high yields are the genotypes of UNEJ-1 and UNEJ-2. Based on the results of the study of Poerwoko *et al.,* 1995, using dialectic crosses 7 x 7 with the parents of soybean genotypes of Wilis, Si Nyonya, Bala-Bala, Genjah Race, Malang 2527,

Ryokko and Occumani. UNEJ-1 genotype is a hereditary the Wilis x Malang crossing 2527, while the genotype UNEJ-2 is the offspring of the Wilis x Occumani crossing. Furthermore Trisusilowati*et al.* (1998) included a resistance gene against leaf rust pathogens (Phakopsorapachyrhizi, Syd) in UNEJ-1 and UNEJ-2 through a method of repeated cross-selection with the parental donor of soy donors from Mr. Cheng Keng Feng (AVRDC), 92-SY-3 and KKS10.2.

Improvement of plant age was carried out with donor Malabar (flowering age and mature age of harvest respectively 31 and 70 days) [3]. The G-1 genotype is the product of the UNEJ-1 x Malabar (1x3) crossing offspring, while the G-3 is the UNEJ-2 x Malabar (2x3) crossing offspring. Genotype-G-2 and Genotype G-3 are descendants of their reciprocal crosses, which are 3x1 and 3x2. Malabar x UNEJ-2 crossing is called Genotype G-5. Soybean seed yield is a complex character associated with several yield components and is affected by environmental fluctuations. Environmental variables such as the growing season, cropping patterns, and soil types often determine the suitability of adaptation of soybean varieties in Indonesia. Such optimization of environmental diversity can be achieved, among others, by providing soybean varieties that are able to adapt and produce relatively the same results in different environments [4].

Each plant cultivar grows under environmental conditions with a wide range in terms of soil type, soil fertility level, humidity level, temperature and different cultivation habits have different effects for plants. All factors that influence in overall crop production can be described as environmental and genetic factor interactions and environmental factors.Soybean plants mostly grow in tropical and subtropical regions. As a climate barometer that is suitable for soybeans is suitable for corn crops. Soybean resistance is better than corn where dry climate is preferred by soybean plants compared to humid climate. To get optimal results, soybean plants require rainfall between 100-200 mm/ month, the desired temperature is between 21-34 °C, where the optimum temperature for growing soybean plants is 23-27 °C. Good soybean harvest time is in the dry season because it is related to the time of cooking the seeds and drying the results [5].

Soybean seed yield is a complex character associated with several yield components and is affected by environmental fluctuations. Environmental variables such as the growing season, cropping patterns, and soil types often determine the suitability of adaptation of soybean varieties in Indonesia. Such optimization of environmental diversity can be achieved, among others, by providing soybean varieties that are able to adapt and produce relatively the same results in different environments [4]. The main soybean producing regions in Indonesia are Central Java, East Java, Lampung and West Nusa Tenggara. Soybeans are planted in dry areas, such as dry fields, fields and gardens. Soybeans are also planted in rice fields in the dry season as crops.Genotype and Environmental Interaction. To increase national productivity of the nation, it can be done by obtaining high-yielding high-yielding varieties and tolerating different environmental factors. The tolerance of a variety or cultivar to some biotic and abiotic constraints greatly determines the distribution of varieties. Indonesia has a very large geophysical macro environment which gives a very large variety of growing environments for plants. The variation of the macro growth environment will not guarantee that a genotype or plant variety will grow optimally and produce high yield in all regions. This is related to the possibility of the interaction of plant genotypes with environmental variations. These interactions will affect the plant morphology growth which is a component of seed yield. The display of quantitative traits is the result of collaboration between genetic and environmental factors, because genetic traits will not display the traits they carry unless they support the environmental factors that support the plant's growth.

The growth of a plant will always be influenced by both internal and external factors of the plant itself. The inner factor of the plant is the genetics of the plant which are expressed through the plants so that the results are obtained, while the external factors are environmental factors that affect climate, temperature, humidity, sunlight intensity and soil fertility. The process of soil development in nature occurs continuously, and is influenced by many factors that interact with one another. Some very important

factors are climate, organisms, host rock, topography, and time. The interaction of these factors determines the rate of weathering of the source rock which the results will compose one of the soil components. The properties of these soil components will further determine the type of soil and its suitability for plants [6].

Each plant cultivar grows under environmental conditions with a wide range in terms of soil type, soil fertility level, humidity level, temperature and different cultivation habits have different effects for plants. All factors that influence in overall crop production can be described as environmental and genetic factor interactions and environmental factors. Eberhart and Russel suggested that stable varieties are those that have a regression coefficient equal to one, and the regression deviation does not differ from zero. The stable varieties according to [7] are roughly the same as the generally adapted varieties according to Finlay and Wilkinson (1963). The weakness of the Eberhart and Russell method is the possibility of releasing varieties that are responsive to productive environments (Regression coefficient> 1.0) [8].

Genotype-environment interaction is very important for plant breeders to improve plant varieties. If several varieties are compared in several environmental series, the relative rank is usually different. This will cause difficulties in showing the real superiority of a variety. [9] Show statistically the influence of genotype interactions with large environments can reduce progress due to selection. Environmental stratification has been widely used to effectively reduce genotype interactions with the environment. The areas where breeders develop improved varieties can often be separated into somewhat similar sub-regions. This stratification is usually based on differences in the macro environment such as temperature, rainfall distribution and soil type [7].

2. Research Method

2.1 Place and time of research
The study was conducted from April to November 2018 at five soybean production centers in East Java, namely the experimental plant Research Institute for Beans and Bulbs (Balitkabi) in Genteng-Banyuwangi, Muneng-Probolinggo, Ngale-Ngawi, Kendal-payak-Malang, and Jember State Polytechnic Experi-ment Garden. The altitude of the study site varies from low to moderate.

2.2 Materials and tools
The research material used is the seed of further segregation from 5 lines of hope are: G-1, G-2, G-3, G-4, G-5, high-production parents Unej-1, Unej-2, Malabar as the elderly donor age early maturing, Ringgit and Wilis as a compari-son. G-1 strain is the result of a cross between Unej-1 x Malabar, while G-2 is the result of a reciprocal crossing. The G-3 strain is the result of a cross between Unej-2 x Malabar, while the G-4 and G-5 lines are the result of crossing the reciprocal reciprocity (Malabar x Unej-2)

2.3 Research methods
The experimental design used for each location was a complete randomized block design with ten treatments (genotypes) and three replications at each location. The size of each plot (unit) of the experiment is 2.8 m x 4.5 m or 12.6 m2. The distance between rows is 40 cm and inside the rows are 15 cm.

2.4 Data analysis
Chi-square test for homogeneity of various errors with the Barlett's test [10] are as follows.

Combined estimator:

$$S^2p = \sum_{i=1}^{k} \frac{S_i^2}{k}$$

Value of chi sguare test =(X^2) (Gomez and Gomez 1984):

$$X^2 = \frac{(2,3026)(f)(k \log S^2 p - \sum_{i=1}^{k} \log S_i^2)}{1 + \{(k+1)/3kf\}}$$

Note :

f = df, k = number of variants tested ,S^2p = Estimate combined variance, $S_i^{\,2}$ = Estimate of Variance

Table 1. Estimate Combined Variance

Source of Variation	Degrre of Freedom	Sums square	Mean Square
Grup (replication x location)	b(n-1) = 16	JKK	KTK
Genotype	a-1= 9	JKA	KTA
Location	b-1 = 7	JKB	KTB
Genotype x Location	(a-1)(b-1) = 63	JK(A*B)	KT(A*B)
Error	b(a-1)(n-1) = 144	JKG	KTG
Total	abn-1 = 239	JKT	

In this case the estimation of variance is σ_g^2 = (KTg-KTe)u

$$\sigma_e^2 = KTe$$

$$\sigma_p^2 = \sigma_g^2 + \sigma_e^2, \text{ and}$$

heritability: $H = \dfrac{\sigma_g^2}{\sigma_p^2}$

F test, testing the real difference between the effect of genotypes and their interactions with the environment, namely:

$$f(g) \quad = KTg / Kte$$

$$f(gxs) = KT(gxs) / KT4)$$

Stability and Adaptability Analysis (Finley and Wilkinson, 1963) Estimation of the parameters of stability-based analysis of variance combined with the method of [7].

Table 2. Combined Analysis of the Eberhart and Russell Model Variations

SK	db	JK	KT
Genotype	(g-1)	$\frac{1}{n}\sum_i Y_i^2 - FK$	M1
L (linear)	1	$\frac{1}{g}\left(\sum_j Y_{ij}I_j\right)^2 / \sum_j I_j^2 \; (s_2)$	M2
Genotype x environment (linear)	(g-1)	$\sum_i [\sum_j (YijIj)^2 / \sum_j I_j^2] - S_2$	M3
Combined deviation	g(i-1)	$\sum_i \sum_j \delta_{ij}^2$	M4
Genotype 1	(I-2)	$[\sum_j Y_{ij}^2 - (Y_{i..})^2 / I] - (\sum_j Y_{ij}I_j)^2 / \sum_j I_j^2$	M5
Genotype v	(I-2)	$[\sum_j Y_{.gj}^2 - (Y_g)^2 / I] - (\sum_j Y_{gj}I_j)^2 / \sum_j I_j^2$	Mv
Combined Error	l(r-1)(g-1)	Dari analisis tergabung	Me

Source [7]

Testing the stability and adaptability parameters of the results used the regression models of [7] as follows: If Yij results of the i-genotype (i = 1, 2, 3 ... v) in the j-th environment (j=1, 2, ... s), then:

Yij = μ + βiIj + δij

in this case:
Yij = Middle value of variety i and environment j
βi = Regression coefficient of i-variety in various environments
δij = Regression deviation from variety i and environment j
Ij = Environmental influences to j
μ = common mean values of all genotypes in all environments

Stability parameters: there are two stability parameters that can be calculated: (a) Regression coefficient, i.e. the regression appearance of each variety under different environments at the environmental mean values of all genotypes. Suspected as follows: $bi = \sum_I Y_{ij} I_j / \sum_j I_i^2$

In this case:

$\sum_g Y_g I_j \quad \sum Y$ Sum of product

$\sum_j I_j^2$ is the sum of the squares of the environmental index ($\overline{s_e^2}$) from linear regression:

$$\frac{\delta^2_{j\;ij}}{s-2} - \frac{S_e^2}{r}$$

$$\sum_{j} \delta_{ij}^2 = \left[\sum_{j-} Y_{ij}^2 - \frac{Y_{ij}^2}{i} \right] - \frac{\left(\sum_{j} y_{ij} I_j \right)^2}{\sum_{j^1} I^2}$$

S_e^2 = estimated error value combined

Calculation of the environmental index(I_i) as follows:

$$I_i = \frac{\sum_{i} Y_{ij}}{i} - \frac{\sum \sum_{ij} Y_{ij}}{ij}$$

Estimation of the regression coefficient for each variety bi = $\sum_{j} Y_{ij} I_j / \sum_{j} I_j^2$

In this case

$\sum_{j} Y_{ij} I_j$ = the number of times the mean value of varieties with the environmental index of each location.

$\sum_{j} I_j^2$ = number of environmental index squares

quare squared deviation from linear regression $\left(\overline{S_e^2} \right) = \frac{\sum_{j} \delta_{ij}^2}{(s-2)} - \frac{S_e^2}{r}$,

in this case $\sum_{j} \delta_{ij}^2 = \left[\sum_{j} Y_{ij}^2 - \frac{Y_i^2}{t} \right] - \frac{\left(\sum_{j} Y_{ij} I_j \right)^2}{\sum_{j} I_j^2}$

S_e^2 = suspected combined error.

Therefore $\sum_{j} \delta_{ij}^2$ is the result of a reduction in the variance due to

Y with the variance caused by regression. While the deviation fromregression (δij) is used to determine the measure of stability

The observed agronomic traits are: Plant height (cm) which is measured at the time of the pre-harvest plants frombase of the stem to the point where the main stem grows; Number of branches.The number of branches is calculated as branches that grow on the main stem; Age of flowering (R2).Age flowering is observed if the flower isin full bloom on one of the most bookstop on the main stem; Age of maturity pods (R7) The age of the cooked pods is observed if the normal pods on the main stem are mostly brownish; Mature harvest age (R8). Mature maturity of the harvest is observed by adding 3-5 days after observing the ageof the mature pods and the pods are dry; Number of filled pods.The number of filled pods was observed by counting all filled pods; 100 seeds weight.Weight of 100 seeds was observed by taking 100 seeds of uniform size from each sample plant then weighed; Yield per hectare (ton / ha).The production per hectare is calculatedfrom the conversion of tile production.

3. Results and Discussion

The results of multilocation tests on high-yielding and early maturing soybean lines in five locations in East Java, namely Banyuwangi, Jember, Probolinggo, Malang and Ngawi, showed that plant growth was not optimal because during the research the climate anomaly occurred during the year 2018 with rainfall. the intensity is quite large in some growing environments, where April should start the dry season. The effect of the occurrence of rain throughout the growing period until harvest is the age of soybean cooking

pods become longer, ranging between 77-79 days and the seeds are not optimal. Based on BPS data that soybean production per hectare in 2018 on the island of Java has decreased productivity

Table 3. Characteristics of Experimental Location, Soil Type, Altitude and Amount of Rainfall

No.	Location/experiment Garden	Soil Type	Altitude (mdpl)	Number of rainy days.
1.	Genteng, Banyuwangi	Entisol	168	35
2.	State Politechnic Jember	Inceptisol	89	32
3.	Kendal Payak Malang	Inceptisol	445	27
4.	Muneng Probolinggo	Alvisol	10	30
5.	Ngale Ngawi	Vertisol	100	38

Entisol is new soil, development is unclear, nutrient poor soil; Inceptisol is a young soil but older than entisol, quite fertile; Alvisol is soil characterized by gray to brown soil surface with moderate to high base content; Vertisol is a soil characterized by high clay content also called Gromusol soil, when dry the soil shrinks so the soil is cracked and hard [11]. A summary of the F values calculated from the results of the combined analysis of the eight test environments for the eight plant characters observed is presented in Table 4.

Table 4. Summary of F Value Calculate the Analysis of the Combined Eight Characters

No.	Agronomic Charracters	Location	Replication/ Location	Genotype	Genotype x Location
1	Plant Height (cm)	312.49**	4.76**	53.38**	9.07**
2.	Number of primer branch	25.37**	1.87ns	1.86ns	1.12ns
3.	Age to flowering (R_2)	585.48**	0.27ns	48.30**	8.70**
4.	Age ripe pods (R_7)	1213.92**	0.55ns	119.87**	24.67**
5.	Mature age harvest (R_8)	1338.29**	0.47ns	67.80**	35.07**
6.	Number of filled pods	77.32**	1.45ns	37.31**	5.60**
7.	100 seed weight	33.78**	0.81ns	103.95**	3.59**
8.	Seed yield per ha	28.29**	1.24ns	2.28**	1.71*

ns = non significant;   * = Significant different;   ** = Higly Significant different

Based on Table 4 above, the location of the experiment was significantly different, whereas for replications in the location only the plant height characteristics were significantly different. For plant genotypes, age of flowering (R2), pod maturity (R7), and maturity of harvest differ significantly, as well as the nature of the number of filled pods, weight of 100 seeds, and yield of seeds per hectare. This shows that there are differences between the ten genotypes tested. Genotype x location interaction, looks significantly different for all traits, except for the nature of the number of primary branches in the main stem. Genotype interactions with the environ-ment are components that affect phenotypic results and expression [12]. In this case the phenotypic response to a change in the environment is not the same for all genotypes. The failure of a genotype to give the same response as other genotypes in different

environments is a definite indication of the interaction of genotypes with the environment. Eberhart and Russell used a regression coefficient (b) between the yield of varieties with the environmental index and the regression deviation ($\delta 2ij$) as a criterion for stability parameters. Genotype is said to be stable if it has a regression coefficient not different from one and the regression deviation is not different from zero.

Table 5. Stability for Seed Yield Parameters per Hectare

Genotype	Code	Average	bi	SE.b	t-Calc	t-Table		Sd²	F-Calc	F-Table		Criteria	
G-1	A	2.87	0.61	0.39	-0.99	2.04	ns	-0.11	0.15	2.70	ns	Stabil	TA
G-2	B	2.81	1.69	0.39	1.74	2.04	ns	-0.08	0.37	2.70	ns	Stabil	TA
G-3	C	2.89	0.94	0.39	-0.15	2.04	ns	0.02	1.16	2.70	ns	Stabil	A -
G-4	D	2.93	0.84	0.39	-0.40	2.04	ns	-0.07	0.44	2.70	ns	Stabil	A -
G-5	E	3.20	1.12	0.39	0.31	2.04	ns	-0.06	0.50	2.70	ns	Stabil	A+
UNEJ-1	F	3.04	0.81	0.39	-0.47	2.04	ns	-0.03	0.74	2.70	ns	Stabil	A -
UNEJ-2	G	3.17	1.11	0.39	0.27	2.04	ns	0.24	2.94	2.70	*	Unstable	A
Malabar	H	3.56	0.83	0.39	-0.43	2.04	ns	0.72	6.73	2.70	*	Unstable	A -
Wilis	I	2.76	1.18	0.39	0.45	2.04	ns	-0.03	0.74	2.70	ns	Stabil	A+
Ringgit	J	3.15	0.87	0.39	-0.33	2.04	ns	0.35	3.80	2.70	*	Unstable	A -
Rerata		**3.04**											

Genotypes G-1, G-2, G-3, G-4, G-5, Unej-1, and Wilis are stable with bi values ranging from 0.81 to 1.69. and the value of t-count regression is all smaller than t-table means that the regression coefficients are not different from one. If the regression coefficient value is not different from 1 and the standard deviation value of the regression coefficient is not different from zero, then the genotype is said to be stable. If the value of the regression coefficient and regres-sion deviation there is one that is significantly different from the F-table of 5%, the genotype is said to be unstable. Unstable genotypes are Unej-2, Malabar, and Ringgit.
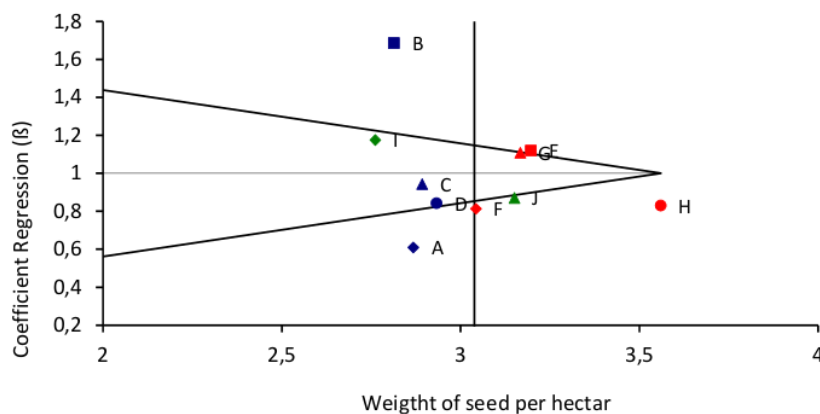
Figure 1. Yield Adaptability (ton/ha)

Based on Table 5 above, the stable G-1 and G-2 genotypes are specifically able to adapt to adverse environments. Genotypes G-3, G-4, Unej-1, Malabar and Ringgit are able to adapt to all environments.

4. Conlusion

Genotypes G-1, G-2, G-3, G-4 and G-5 and UNEJ-1 are stable in five locations, while UNEJ-2, Malabar and Ringgit are apparently unstable; and G-1 and G-2 genotypes are particularly stable capable of adapting to unfavorable environments. Genotypes G-3, GF4, Unej-1, Malabar and Ringgit is able to adapt to allenvironments

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