STUDY ON RELATIONSHIP BETWEEN AGRONOMIC CHARACTERS AND FARMING VALUE IN SOYBEAN VARIETIES ASSESSMENT

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ABSTRACT

Soybean is important commodity because it is consumed by the whole communities. Soybean plays important role in national food security. In fact, the needs for soybeans currently still depend on import of soybean seeds. The stakeholders and communities have made some efforts to increase soybeans production, and one of them is providing superior and high-qualified varieties, as well as profitable for farming. Objective of the study was to know relationship between agronomic characters and economic values in soybean varieties assessment. The study was to analyze the farming of new superior varieties in comparison with local superior varieties by applying different dose of fertilizer. Furthermore, the research was carried out to look for superiorities of the varieties before they are released. Conclusions of the research are (1) the harvest yield per hectare showed that the treatment of YS2 and YS3 have the highest yields with average values 2.4 and 2.2 tons/ha, respectively. (2) The highest farming income was derived from the treatment of YS0, (3) Extra expenses for farming which were expended for both varieties of Yasi 6 and Grobogan will be able to increase the harvest yield but could not afford to raise income, (4) Yasi 6 could be cultivated in accordance with the farmers’ habits and will be able to raise income.

Keywords: Soybean, agronomic, farming, yield, correlation

INTRODUCTION

Soybean is an essential commodity in food security system. Soybean is consumed by almost the whole communities and contains good nutrients for human. Soybean is foodstuff that contains protein, fiber, oil, antioxidant, and other substances, which are very useful for human health (Gupta et al., 1973; Sign and Hymowitz, 1999; Sruamsiri and Silman: 2008; Djanta et al., 2020).

Today, the needs for soybean are fulfilled by domestic production and import soybean commodities. Efforts to fulfill the needs for soybean are striven by the government and
Developing crop varieties can be done through breeding. The improved breeding was conducted by domestic breeding program and introducing new varieties from overseas genetic sources (Miladinoviæ et al., 2011). The breeding steps include creating lines, progeny test, productivity test, resistance test to pest and disease, resistance test to abiotic stress and adaptation test, as well as multilocation with diverse methods in crops breeding (Sign and Hymowitz, 1999; Kustanto et al., 2012; Louwaars, 2018; Mudzakir et al., 2019).

Assessment on a variety tends to be determined by conspicuous characters that relate to genetic, physiological, and morphological characters (Turmuktini et al., 2020). In fact, the farmers prefer the superior varieties due to superiorities of the agronomic characters and the economic value of the varieties, so that the varieties will be profitable for their farms (Miladinoviæ et al., 2011, Djanta et al., 2020).

Farm operation is an organization of production, which is conducted by farmers. Farmers are the farm producers who organize the land, labor, and capital, which are directed to crops production and gain profit. Factors that affect farm operation are economic, technical, and social factors. Economic factor is a capital control. Technical factors are land and commodity that include: varieties production potency, resistant of the varieties to pest and disease, adaptability and suitability to climate. Social factors include the prevailing habits, labor, education of the farmer and social environment of the community (Richards, 2015; Kolar et al., 2021).

Objectives of the research were to study the relationship between agronomic characters and economic values in soybean assessment varieties which was the farm operation of the new superior varieties was compared to local superior varieties by the application of different dose of fertilizer. Furthermore, this research was conducted to look for superiority of crop varieties, determine appropriate fertilization technology and gain high profits.

**MATERIALS AND METHODS**

Materials of the research include seeds of Yasi 6 from partner of Yayasan Agrisustineri Indonesia which is in the research stage and Grobogan varieties, which were planted using Randomized Block Design (RBD) with 3 replications. There were 8 doses of fertilizer treatments, which were adopted from the farmers’ habits in various regions in Indonesia, namely: (1) G0: Grobogan variety without fertilizer, (2) G1: Grobogan variety with NPK 16:16:16 as much as 1.67 ton/ha, (3) G2: Grobogan variety with NPK 15:15:15 as much as 3.33 ton/ha, (4) G3: Grobogan variety with single fertilizer (Urea: 0.42 ton/ha SP-36: 2.50 ton/ha and KCl: 1.25 ton/ha), (5) YS0: Yasi 6 variety
without fertilizer; (6) YS1: Yasi 6 variety with NPK 16:16:16 as much as 1.67 ton/ha, (7) YS2: Yasi 6 variety with NPK 15:15:15 as much as 3.33 ton/ha, and (8) YS3: Yasi 6 variety with single fertilizer (Urea: 0.42 ton/ha, SP-36: 2.50 ton/ha and KCl: 1.25 ton/ha).

Cultivation was conducted on plots by a given size of 6.0 m x 10.0 m and drainage depth of 30-40 cm. The observed qualitative characters are as follow: average plant height (cm), number of filled pods per plant (fruit), harvest age (days after planting/dap) and harvest yield per hectare (ton). Data of the research was analyzed using Anova program DSAASTAT, continued with the Least Significant Difference (LSD) test at level p = 0.05.

Farming value was approached by farm analysis which is calculation on net farm income, which is defined as the difference between the gross farm income and total expenditure of the farm. The difference income of the farm can be used to measure the rewards, obtained for farmers in terms of the use of factors of production work, management, and capital. The farm income can be formulated as follows: $\pi = \text{TR} - \text{TC}$, in which $\pi = \text{Net Farm Income (IDR)}$, $\text{TR} = \text{Total Revenue (IDR)}$, $\text{TC} = \text{Total Cost (IDR)}$ (Saedah et al., 2019; Kolar et al., 2021). In this study, additional cost is used to count the variable cost that relates to the different application of seeds and fertilizers. The assumed prices for seeds and fertilizers are: the seeds price for Grobogan variety is assumed as 1 unit and Yasi 6 variety is assumed as 2.5 units. The prices of each fertilizer in unit are as follow: NPK 16:16:16 = 4.0 units, NPK 15:15:15 = 3.0 units, Urea = 1.0 unit, SP36 = 1.3 units and KCL = 3.5 units.

Close relationship between the observed characters and the farm components is conducted by simple correlation analysis. Equation for the agronomic characters correlation coefficient ($r$) and the farm components ($y$) is: $r_{xy} = \frac{\text{Cov}(x, y)}{\sqrt{\text{Cov}(x, x) \cdot \text{Cov}(y, y)}}$, $\text{Cov}(x, y) = \text{covariant of properties} x \text{ and } y$, $\sigma^2(x) = \text{variety of agronomic characters (x)}$ and $\sigma^2(y) = \text{variety of farm components (y)}$, $\text{Cov}(x_1, x_2) = \text{covariant between variables} x_1 \text{ and } x_2$, $\sigma^2(x) = \text{variety of } x_1 \text{ and } \sigma^2(x) = \text{variety of } x_2$ (Singh and Chaudhary, 1979; Kustanto et al., 2012).

**RESULTS AND DISCUSSION**

**Agronomic Characters**

Results of F-test at level $p = 0.05$ indicated that the character of plant height has significant effect. Results of LSD test on character of plant height showed that the treatments of YS2 and YS3 have the highest values, on average, and insignificantly different 92.1 and 92.3 cm, respectively. The treatment of G0 showed the lowest value, 73.5 cm, on average. The average values for plant height were found on YS0, YS1, YS2, and YS3 were higher and different from G0, G1, G2, and G3. These indicated that Yasi 6 is more favorable variety than Grobogan.

Results of F-test at level $p = 0.05$ indicated that the character on number of pods has
significant effect. Results of LSD test on number of pods showed that the treatments of YS1, YS2 and YS3, on average, have the highest values and insignificantly different as follow 79.5, 84.2 and 80.5, respectively. Number of pods on the treatments of G0, G1, G2, G3 showed the lowest values and insignificantly different on each treatment were 34.5, 45.3, 38.9 and 40.5, respectively. Average value for number of pods on the treatments of YS0, YS1, YS2 and YS3 were higher than G0, G1, G2 and G3. These indicated that Yasi 6 varieties have more pods than Grobogan varieties.

Results of F-test at level p = 0.05 indicated that the character of harvesting period has significant effect. Results of LSD test on character of harvesting period showed that the treatments of YS0, YS1, YS2 and YS3 have high values on average as follow 117.3, 119.3, 118.0, and 120.3 dap, respectively, while G0, G1, G2, and G3 showed the lowest values on average as follow 78.3, 77.0, 81.3, and 80.3 dap, respectively. These results indicated that Yasi 6 varieties have longer harvesting period than Grobogan Variety.

Results of F-test at level p = 0.05 on character of harvest yield per hectare showed that harvest age has significant effect. Results of LSD test on the harvest yield per hectare showed that the treatments of YS2 and YS3 have the highest yield with average value is 2.4 and 2.2 ton/ha, respectively. The treatment of G0 showed the lowest harvest yield per hectare, on average, 1.1 ton/ha. Average values of harvest yield per ha on the treatments of YS0, YS1, YS2, and YS3 were little higher than G0, G1, G2, and G3. These results indicated that Yasi 6 varieties showed higher harvest yield/ha than Grobogan varieties. Results of the test on the whole agronomic characters are presented in Table 1.

Data of the test showed that soybean with treatment without inorganic fertilizer is favorable for Yasi 6 and Grobogan varieties, which are able to produce favorable harvest yields. It is due to soybean is able to bond nitrogen from the air (Whitehead and Isaac, 2012). The application of single as well as compound fertilizers from nitrogen, phosphor, and potassium will significantly increase the

**Table 1. Agronomic characters on each treatment**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>G0</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>YS0</th>
<th>YS1</th>
<th>YS2</th>
<th>YS3</th>
<th>LSD 5%</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Height (cm)</td>
<td>73.5</td>
<td>74.7b</td>
<td>72.9c</td>
<td>77.8b</td>
<td>84.1b</td>
<td>88.8b</td>
<td>92.1a</td>
<td>92.3a</td>
<td>2.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Number of Pods (fruit)</td>
<td>34.5</td>
<td>45.3c</td>
<td>38.9c</td>
<td>40.5c</td>
<td>61.1b</td>
<td>79.5a</td>
<td>84.2a</td>
<td>80.5a</td>
<td>58.1</td>
<td>12.7</td>
</tr>
<tr>
<td>Harvesting Period (Dap)</td>
<td>78.3b</td>
<td>77.0b</td>
<td>81.0b</td>
<td>80.3b</td>
<td>117.3a</td>
<td>119.3a</td>
<td>118.0a</td>
<td>120.3a</td>
<td>5.5</td>
<td>3.7</td>
</tr>
<tr>
<td>Harvest Yield</td>
<td>1.1d</td>
<td>1.3c</td>
<td>1.3c</td>
<td>1.4c</td>
<td>1.2cd</td>
<td>2.1ab</td>
<td>2.4a</td>
<td>2.2a</td>
<td>0.7</td>
<td>13.1</td>
</tr>
</tbody>
</table>

Notes: (1) G0: Grobogan variety without fertilizer, (2) G1: Grobogan variety with NPK 16:16:16 as much as 1.67 ton/ha, (3) G2: Grobogan variety with NPK 15:15:15 as much as 3.33 ton/ha, (4) G3: Grobogan variety with single fertilizer (Urea: 0.42 ton/ha SP-36: 2.50 ton/ha and KCl: 1.25 ton/ha), (5) YS0: Yasi 6 variety without fertilizer; (6) YS1: Yasi 6 variety with NPK 16:16:16 as much as 1.67 ton/ha, (7) YS2: Yasi 6 variety with NPK 15:15:15 as much as 3.33 ton/ha, and (8) YS3: Yasi 6 variety with single fertilizer (Urea: 0.42 ton/ha SP-36: 2.50 ton/ha and KCl: 1.25 ton/ha), CV = coefficient of variation, LSD= Least Significant Difference, Dap= Days after planting.
harvest yields (Wijanarko and Taufiq, 2011; Duaja et al., 2022).

**Farming Analysis**

The treatment of fertilizer dose on Yasi 6 and Grobogan varieties will change the total cost of production (TC) in soybean farming. Difference cost of soybean farming on each treatment was due to different expenditure cost for seeds and inorganic fertilizers, which so-called additional cost (AC). Variations in additional cost (AC) and in harvest yield/ha caused variations in profit obtained from each treatment.

G0 treatment required additional cost = 0.0, total cost (TC) = 13.7, total revenue (TR) = 19.3 and net farm income ($\pi$) was 5.5. G1 required additional cost = 13.3, total cost (TC) = 27.1, total revenue (TR) = 21.0 and net farm income ($\pi$) was -6.1. G2 required additional cost = 20.0, total cost (TC) = 33.7, total revenue (TR) = 21.5 and net farm income ($\pi$) was -12.2. G3 required additional cost = 15.8, total cost (TC) = 29.6, total revenue (TR) = 22.1 and net farm income ($\pi$) was -7.5. (Table 2.)

Treatment of YS0 required additional cost = 0.8, total cost (TC) = 14.5, total revenue (TR) = 23.2 and net farm income ($\pi$) was 8.7. YS1 required additional cost = 14.1, total cost (TC) = 27.8, total revenue (TR) = 32.5 and net farm income ($\pi$) was 4.7. YS2 required additional cost = 20.8, total cost (TC) = 34.5, total revenue (TR) = 36.9 and net farm income ($\pi$) was 2.4. YS3 required additional cost = 16.6, total cost (TC) = 30.3, total revenue (TR) = 32.2 and net farm income ($\pi$) was 1.9 (Table 2.).

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**Table 2. Farm analysis on each treatment (unit, IDR)**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>G0</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>YS0</th>
<th>YS1</th>
<th>YS2</th>
<th>YS3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
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<td>7</td>
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<tr>
<td>1</td>
<td>Land Lease</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Seeds</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>b. Organic fertilizer</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>c. Inorganic fertilizer</td>
<td>0</td>
<td>13.3</td>
<td>20</td>
<td>15.8</td>
<td>0</td>
<td>13.3</td>
<td>20</td>
<td>15.8</td>
</tr>
<tr>
<td></td>
<td>d. Dolomite</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>e. Pesticide</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>3</td>
<td>Labor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Tillage</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>b. Cultivation</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>c. Weeding</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>d. Pest &amp; Disease Control</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
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</tr>
<tr>
<td></td>
<td>e. Harvesting</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>f. Transporting</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
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<tr>
<td></td>
<td>g. Drying</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>4</td>
<td>Total Additional Cost (TA)</td>
<td>0</td>
<td>13.3</td>
<td>20</td>
<td>15.8</td>
<td>0.8</td>
<td>14.1</td>
<td>20.8</td>
<td>16.6</td>
</tr>
<tr>
<td>5</td>
<td>Total Cost (TC)</td>
<td>13.7</td>
<td>27.1</td>
<td>33.7</td>
<td>29.6</td>
<td>14.5</td>
<td>27.8</td>
<td>34.5</td>
<td>30.3</td>
</tr>
<tr>
<td>6</td>
<td>Total Revenue (TR)</td>
<td>19.3</td>
<td>21.5</td>
<td>21.5</td>
<td>22.1</td>
<td>23.2</td>
<td>32.5</td>
<td>36.9</td>
<td>32.2</td>
</tr>
<tr>
<td>7</td>
<td>Net farm income ($\pi$)</td>
<td>5.5</td>
<td>-6.1</td>
<td>-12.2</td>
<td>-7.5</td>
<td>8.7</td>
<td>4.7</td>
<td>2.4</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Notes: (1) G0: Grobogan variety without fertilizer, (2) G1: Grobogan variety with NPK 16:16:16 as much as 1.67 ton/ha, (3) G2: Grobogan variety with NPK 15:15:15 as much as 3.33 ton/ha, (4) G3: Grobogan variety with single fertilizer (Urea: 0.42 ton/ha SP-36: 2.50 ton/ha and KCl: 1.25 ton/ha), (5) YS0: Yasi 6 variety without fertilizer; (6) YS1: Yasi 6 variety with NPK 16:16:16 as much as 1.67 ton/ha, (7) YS2: Yasi 6 variety with NPK 15:15:15 as much as 3.33 ton/ha, and (8) YS3: Yasi 6 variety with single fertilizer (Urea: 0.42 ton/ha SP-36: 2.50 ton/ha and KCl: 1.25 ton/ha).
The data showed that additional cost of farm (TA) on both varieties could increase the harvest yields, but it did not raise the farmers’ income. Grobogan and Yasi 6 varieties offer the highest profits on farming operation, which conform to the farmers’ habits. Therefore, it can be said that cost for soybean farming on both varieties was low. In general, the soybean farmers cultivate their crops with more efficient cost and condition (Asmara, et al. 2017). It indicated that Yasi 6 as introduction variety could be bred by following the breeding ways of local farmers without the application of excessive inorganic fertilizers. Yasi 6 variety shows higher production per hectare, on average, than Grobogan variety, but has longer harvesting period, while Grobogan variety shows lower production per hectare, on average, than Yasi 6, but has shorter harvesting period. The farmers’ strategies in selecting varieties that have short harvesting period as well as longer harvesting period were adjusted to seasons, cultivation patterns, and the farmers’ habits on the cultivation area.

**Relationship between agronomic characters and economic values**

Relationship between agronomic characters and economic values of farming components include:

a. Relationship between additional cost (TA) and the harvest yield per hectare

Relationship between the harvest yield per hectare and the additional cost is: $Y = 0.04X + 1.13$, so that the higher additional cost will increase the crop yields per hectare. $R^2$ is 0.36 that indicates less strong relationship between additional cost and the harvest yield per hectare (Graphic 1.).

b. Relationship between the harvest yield per hectare and total revenue (TR)

Relationship between the harvest yield per hectare and the extra costs is: $Y = 12.69 X + 5.42$, so that the higher the harvest yield per hectare will increase total revenue (TR). $R^2$ value is 0.96 which indicates very strong relationship between the harvest yield per hectare and total revenue (TR) (Graphic 2.).

![Graphic 1](image-url)  
**Graphic 1** Relationship between the harvest yield per hectare and additional cost (TA)
a. Relationship between harvest yield per hectare and farming income (π)

Relationship between the harvest yield per hectare and farming income (π) is: 
\[ Y = 3.45X - 6.96 \]
so that the higher the harvest yield will decrease the farming income (π). \( R^2 \) value is 0.06 which indicates less strong relationship between the harvest yield per hectare and the farming income (π) (Graphic 3.).

b. Relationship between Farming Income (π) and Total Cost (TC)

Relationship between farming income (π) and total cost (TC) is: 
\[ Y = -0.58X + 15.49 \]
so that the decreasing costs will raise farming income (π), \( R^2 \) value is 0.39 that indicates quite strong relationship between farming income (π) and total cost (TC) (Graphic 4.).
The harvest yield and farming components have less strong to very strong relationship. The harvest yield per hectare and extra cost have quite strong relationship ($R^2 = 0.36$). The harvest yield per hectare and extra cost have very strong relationship ($R^2 = 0.96$). Farming income and total costs have quite strong relationship ($R^2 = 0.39$). Harvest yield per hectare and farming income have less strong relationship ($R^2 = 0.06$). Along with the tight competition in development of marketing the soybean seeds varieties, it is important to analyze relationship between agronomic characters and economic values of farming components to support the product (soybean seed varieties) determination and development process that have favorable agronomic characters and profitable to farming (Whitehead and Isaac, 2012; Kolar et al., 2021).

**CONCLUSIONS**

Conclusions of the study are: (1) There was strong relationship among agronomic characters and economic values of farming components. (2) The harvest yield per hectare showed that the highest yields by the treatments of YS2 and YS3, on average, were 2.4 and 2.2 tons/ha, respectively. (3) The highest farming income was derived from the treatment of YS0, 8.7 units. (4) Extra cost for farming, which was expended for both varieties of Yasi 6 and Grobogan will be able to increase the harvest yields, but could not afford to raise income. (4) Yasi 6 could be cultivated in accordance with the farmers’ habits and could raise income.

**REFERENCES**


