Growth and results response of two soybean varieties toward fertilizing package at acid dry land in Aceh Province

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Abstract. Acidic dry land is a potential suboptimal land as a source of agricultural production with proper management and utilization. The aim of this research is to determine the growth response and soybean yields of Kipas Merah and Demas varieties to several fertilizer packages. This research was conducted in July to October 2018 in Pidie Jaya Regency of Aceh Province. The study design used a randomized block design (RBD) with 3 replications and in each treatment set 15 plants as samples. The first factor is the variety (V), that is V1 = Kipas Merah; V2 = Demas. The second factor is fertilization package (P) consisting of 2 (two) levels: P1 (specific location) (2 tons/ha organic fertilizer, ameliorant 500 kg/ha and NPK 150 kg/ha); P2 (Recommendation) (urea 75 kg/ha, SP-36 100 kg/ha, KCl 100 kg/ha, ameliorant 500 kg/ha). The results showed the Demas variety with the recommended package gave the highest production of 1.97 tons/ha.

1. Introduction

Soybean (Glycine max L. Merr) is one of the common sources of vegetable protein and ranks as the third main food commodity after rice and corn for the Indonesian people. [17] stated soybean as a food source which rich in protein and functional food. It plays an important role in improving national food security. However, the low interest of farmers, the lack of development of the application of technology advised at the farm level and the competition in the use of land resources with other commodities such as corn are some of the problems that make national soybean production low as well as the increasing of soybean imports [18]. Therefore, The Ministry of Agriculture launched the soy self-sufficiency program from 2015 to 2019 as one of the strategic targets. Currently, the average national productivity of soybean is only 1.6 tons/ha in the range of 0.6–2.0 tons/ha at the farm level, whereas at the research level it has reached 1.7–2.2 tons/ha, depending on land conditions and technology applied. Aceh is one of the largest soybean producers on Sumatra Island with production reaching ± 47,904 tons with a productivity of 1.5 tons/ha [2]. One of the places of production is in Pidie Jaya Regency with a planting area of 487 ha and production of 757.86 tons with the productivity of 1.46 tons/ha [2].

Annually, the optimal area of agricultural land in Indonesia decreases due to biotic and abiotic strains and the conversion of agricultural land to non-agricultural. Utilization of sub-optimal land into agricultural land can be an alternative. One of the potential suboptimal lands for soybean development is acid dry land. Acidic dry land is a stretch of land that has never been flooded for most of the year, acid soil reaction (pH <5) and base saturation <50% [12].
However, there are some technical obstacles encountered in the development of soybean in acidic soils such as the low soil pH (<5.0) associated with high Al levels, high P fixation, low alkaline exchangeable content, and low CEC, Fe and Mn content which reach the limit of poisoning and often contain poor biotic elements. Soybean in acid dry land will be poisoned by H⁺ ions and consequently can affect cell membranes [4]. [1], once said that to improve soybean on suboptimal land it is necessary to improve the aspects of soil fertility such as the use of organic fertilizer, biological fertilizer, lime, etc. Suboptimal land is a land that naturally has one or more constraints so it takes extra effort to be used as productive cultivation land for plants [10].

Moreover, working on the suboptimal land requires proper technology and it makes the role of technology is essential in the development of national soybeans. The provision of suitable varieties for the environmentally concerned and the fulfilment of nutrients that can be done through fertilization are two of the efforts to support the development of soybean cultivation in the agroecosystem that eventually is expected to accelerate plant growth and development as well as to improve the quality and quantity of yields. Superior variety technology has contributed very significantly in the development of national soybeans [16]. About 80% of the total soybean harvest area which reaches 0.7 million hectares is dominated by the use of high yielding varieties. In 2014, the Ministry of Agriculture released the Demas 1 variety as a VUB of dry-acid, adaptive dry land with Minister of Agriculture Decree No. 1176/Kpts/SR.120/11/2014. The purpose of this study was to determine the response of growth and yield of soybean Kipas Merah and Demas varieties to several fertilizer sets.

2. Methodology

The materials used in this study were soybean varieties Kipas Merah and Demas, organic fertilizer, dolomite, NPK, Urea, SP-36, and KCl fertilizers. This research was conducted from July to October 2018 in Pidie Jaya District, Aceh. The study used a randomized block design (RBD) with 3 replications and at each consultation set 15 plants as samples. The first factor was the soybean variety (V), which is V1 = variety Kipas Merah; V2 = variety Demas. The second one was the fertilizer package (P) consisting of 2 (two) levels: P1 (specific location) (2 tons/ha of organic fertilizer, 500 kg ha ameliorant and NPK 150 kg/ha); P2 (Prescription) (urea 75 kg/ha, SP-36 100 kg/ha, KCl 100 kg/ha, ameliorant 500 kg/ha).

The variables observed were vegetative and generative phase growth including plant height at ages 30 and 60 DAP (Day After Planting), number of filled pods per plant, number of empty pods per plant, number of seeds per plant, the weight of seeds per plant, the weight of 1000 grains and yield. The observed data were analyzed of variance for diversity and continued with Tukey’s studentized range test at the 5% level to figure out the level of feasibility of soybean technology sets in dry acid land in Aceh.

3. Results And Discussion

3.1. Characteristics agro ecosystem of the study location

Climate characteristics of the study sites show high rainfall during 2018 [2]. In addition, based on the results of soil analysis containing low nutrients and acidic soil conditions at the study location. Climate and soil characteristics of the study site by Figure 1 and Table 1.
Figure 1. Climate characteristics of the study location (mm)

Table 1. Soil Chemical Analysis Results in Sarah Panyang Village, Kec. Bandar Baru, Kab. Pidie Jaya, 2018.

| No. | Parameter                       | Analysis results | Criteria   |
|-----|--------------------------------|------------------|------------|
| 1.  | Texture                        |                  |            |
|     | - Sand (%)                     | 15.42            | Silty clay |
|     | - Silt (%)                     | 38.26            |            |
|     | - Clay (%)                     | 46.32            |            |
| 2.  | pH                             | 5.00             | Acidic     |
|     | - H2O                           |                  |            |
| 3.  | Organic ingredients            |                  |            |
|     | - C-Organic (%)                | 0.40             | Very Low   |
|     | - Amount of N (%)              | 0.10             | Low        |
|     | - C/N                          | 4.08             | Very Low   |
| 4.  | Extract HCl 25%                |                  |            |
|     | - P2O5 (mg/100 g)              | 6.69             | Very Low   |
|     | - K2O (mg/100 g)               | 17.07            | Low        |
| 5.  | P-Bray (ppm P2O5/100 g)        | 6.20             | Low        |
| 6.  | K-Morgan (K-dd cmol/100 g)     | 0.18             | Low        |
| 7.  | KTK (cmol(+)/kg)               | 14               | Low        |

Analyzed at the Soil and Plant Laboratory of Aceh Assessment Institute of Agricultural Technology

3.2. Analysis results vegetative growth dan yield of soyben

Vegetative growth plays a crucial part for development in the generative phase. Optimal vegetative growth will encourage optimal generative growth so that high yields will be obtained. Observation of plant height is one of the main parameters to determine the level of adaptation of a variety in an agro
ecosystem. The result of the analysis of variance showed that the treatment of varieties and fertilizers affected various observational variables. The results of ANOVA analysis of the observed variables are shown in table 2.

Table 2. The results of the analysis of variance the observed variables

| Variable                     | Treatment | Varieties | Fertilization | Interaction |
|------------------------------|-----------|-----------|---------------|-------------|
| Plant height 30 DAP          |           | tn        | tn            | tn          |
| Plant height 60 DAP          | **        | **        | *             |             |
| Hollow pods                  | **        | *         | tn            |             |
| Filled pods                  | tn        | *         |               |             |
| Seeds weight                 | **        | **        | tn            |             |
| Number of seeds per plot     | **        | **        | *             |             |
| Weight of 100 seeds          | **        | *         |               |             |
| Yield/Production (t/ha)      | **        | **        | tn            |             |

Note: tn = not significant effect, * = significant effect (0.05), ** = Very significant effect (0.01)

Table 3. The average response of plant height at 30 and 60 DAP the treatment of soybean varieties and fertilizer packages.

| Variable                     | Treatment | \( V_1 P_1 \) | \( V_1 P_2 \) | \( V_2 P_1 \) | \( V_2 P_2 \) |
|------------------------------|-----------|---------------|---------------|---------------|---------------|
| Plant height 30 DAP          |           | 36.87         | 36.5          | 41.53         | 36.5          |
| Plant height 60 DAP          |           | 54.95 c       | 62.97 b       | 67.6 ab       | 68.87 a       |

Note: Numbers followed by the same letter on the same line show no significant difference (HSD 0.05).

The results of the analysis of variance showed that the combination of varieties treatment and fertilization package did not significantly affect plant height at 30 DAP observations where the highest yields could be seen in the treatment of Demas varieties by fertilizing the recommendation of 41.53 cm. Observations at 60 DAP showed that fertilization significantly affected the plant height of the Red Fan variety, while the soybean plant height of the Demas variety did not significantly affect fertilization treatment. [15], stated that giving K up to a dose of 160 kg/ha had no significant effect on plant height at ages 30 and 60 DAP. [5], said that the administration of NPK doses of 100 kg/ha; 125/ha; and 150 kg/ha did not significantly affect soybean plant height. However, it is different from the results of the study of [13], which states that giving a dose of Urea 75-100 kg/ha can increase height growth. [9], states that in addition to environmental factors, plant growth is also influenced by factors that exist within the variety itself [9].
Table 4. The average number of filled pods per plot, hollow pods per plot, and seed weight in the treatment of varieties and fertilizer packages.

| Treatment    | Parameter       | Filled pods | Hollow pods | Seeds weight (gr) |
|--------------|-----------------|-------------|-------------|------------------|
| VARIETIES    |                 |             |             |                  |
| Kipas Merah  |                 | 137.40 a    | 39.73       | 16.97 a          |
| Demas        |                 | 282.27 b    | 46.67       | 23.63 b          |
| FERTILIZATION|                 |             |             |                  |
| Specific     |                 | 176.00 a    | 48.00 b     | 18.37 a          |
| Location     |                 | 243.67 b    | 38.40 a     | 22.23 b          |
| Recommendation|                | 198.00 a    | 42.00 b     | 20.00 a          |

Note: Numbers followed by the same letter on the same line show no significant difference (HSD 0.05).

The results of variance showed that the variety and fertilizer application significantly affected the treatment of the number of filled pods and seed weight per plot. Whereas the fertilizer package has a significant effect on the number of empty pods produced. The Demas variety has the highest number of filled pods and seed weight per plot with the best fertilizer set found in the prescribe fertilizer set. [7], states that the formation and filling of pods are largely determined by genetic traits and nutrient adequacy in these plants. Furthermore, [8] added that the variety plays an important role in determining the components of soybean yield because to achieve high productivity is largely defined by the potential yield of the superior varieties planted. Besides, the number of pods formed is also influenced by certain nutrients that play a role in flower growth.

Table 5. The average number of seeds per plot and weight of 100 seeds for varieties and fertilizer treatment.

| Parameter            | Treatment     |
|----------------------|---------------|
|                      | V₁P₁ | V₁P₂ | V₂P₁ | V₂P₂ |
| Number of seeds per plot | 148.87 b | 163.00 b | 205.27 b | 326.13 a |
| Weight of 100 seeds   | 10.74 a   | 9.59 b | 10.86 a | 10.80 a |

Note: Numbers followed by the same letter on the same line show no significant difference (HSD 0.05).

The variance results on the number of seeds and weight of 100 seeds showed a combination of the treatment of Demas varieties with recommendation fertilizer application gave the best results. This is related to the process of forming and filling pods which is largely determined by the genetic traits of the varieties and nutrient adequacy when the process takes place. The number of plant seeds will usually affect the production obtained. This is consistent with the opinion of [6] which states that the productivity of a variety of plants is determined by the interaction of genetic factors with the growth environment such as soil fertility, water availability, and plant management. [11] said that the highest total N content could also affect seed formation because nitrogen is a chlorophyll forming component which is the main source in the photosynthesis process which produces carbohydrates and energy for building the structure of the plants including flowers and fruit. [14] added that the nutrient P can also be able to stimulate the growth of flowers, fruit and seeds and be able to accelerate the ripening of fruit and make the fruit more moisturized.
Table 6. The average yield/production of soybean plants in the treatment of varieties and fertilizer packages

| Treatment | Parameter          | Yield/Production (t/ha) |
|-----------|--------------------|-------------------------|
|            |                    | VARIETIES               |                               |
|            |                    | V₁                       | 1.53 b                     |
|            |                    | V₂                       | 1.97 a                     |
|            |                    | FERTILIZATION            |                               |
|            |                    | P₁                       | 1.55 b                     |
|            |                    | P₂                       | 1.86 a                     |

Note: Numbers followed by the same letter on the same line show no significant difference (HSD 0.05).

From the results of the variance on soybean yields in the treatment of varieties and fertilizer packages, it was observed that the varieties and fertilizer packages significantly affected the results where the highest yields were obtained by Demas varieties and fertilizer package recommendations. This shows that the Demas variety has adaptability and develops well in acid soils in combination with a recommendation fertilizer application. These results are the same as the results of the previous observations on the number of seeds and seed weight. The number of plant seeds will usually affect the production obtained.

4. Conclusion and Recommendation

The combination of Demas variety and approval fertilizer (V2P2) gives the best results in plants height of 60 DAP. In crop production, independent treatment of Demas (V2) varieties is better than Kipas Merah (V1) varieties and recommendation fertilizer (P2) is better than specific location fertilizer (V1).

References

[1] Barus, J. 2013. Potential development and cultivation of soybeans on suboptimal land in Lampung. Proceedings of the National Seminar on Suboptimal Land. Palembang, 20-21 September 2013

[2] BPS Aceh. 2018. Aceh in figures 2018. Banda Aceh.

[3] BPS Pidie Jaya. 2018. Pidie Jaya in Numbers 2017. Pidie Jaya.

[4] Ermolayev, V. 2001. Isolation of genes involved in soybean response to Al toxicity under Low pH condition. p.15–24 In N. Sunarlim, M. Machmud, W.H. Adil, F. Salim, and I.N. Orbani (Eds.). Proc of Workshop on Soybean Biotech for Aluminum Tolerance on Acid Soils and Disease Resistance. Federal Ministry for Education and Res., Germany. Central Res. Inst. for Food Crops. Bogor

[5] Fahmi, N., Syamsuddin, A. Marlin. 2014. Effect of organic and inorganic fertilizers on the growth and yield of soybean (Glycine max (L.) Merril). Floratek Journal, vol. 9 (2): 53 - 62.

[6] Gani, J. A., 2000. Soybean of New Superior Varieties. Mataram Agricultural Research and Technology Research Institute. Mataram.

[7] Hidayat, O. O. 1985. Morphology of Soybean Plants. In Sojidmadja and Yuswadi. 1985. Soybean. Bogor Food Crop Research and Development Center.

[8] Irwan, A.W. 2006. Cultivation of Soybean (Glycine max (L.) Merril). Department of Agriculture Cultivation, Faculty of Agriculture, Padjadjaran University, Bandung

[9] Jumin, H. B. 2005. Agronomy Basics. Revised Edition. P. T. Raja Grafindo Persada. Jakarta.

[10] Lakitan, B. and N. Gofar. 2013. Technology innovation policies for sustainable sub-optimal land management. Proceedings of the National Seminar on Suboptimal Land.

[11] Lutfi. 2007. Chemical Sciences. Jakarta: Erlangga.
[12] Mulyani, A., Hikmatullah and H. Subagyo. 2003. Characteristics and Potential of Soil Dry Soil in Indonesia. Proceedings. National Symposium on Land Utilization. 29-30 September 2003. Bandar Lampung.

[13] Muzammil, D., Rusmawan, and Asmaransyah. 2012. Effect of nitrogen doses on the growth and production of soybeans in the former Bangka Tengah tin mining area, Bangka Belitung Islands. Proceedings of the National Seminar on Agricultural Research Innovation and Assessment of Agricultural Technology. Lampung AIAT. Agricultural Research and Development Agency, Ministry of Agriculture. Pages 111 - 118.

[14] Novizan. 2005. Instructions for Effective Fertilization. Agromedia Reader. Jakarta.

[15] Nursyamsi, D. 2006. Nutrient potassium nutrient requirements in Ultisol soil. Journal of Soil and Environmental Sciences, vol. 2 (6): 71 - 8.

[16] Suyamto, and I.W. Widiarta. 2011. National soybean development policy. Proceedings of the Symposium and Exhibition of Isotope and Radiation Application Technology

[17] Tastra, I.K., Erliana, G. and Gatot S. A. Fatah, 2012. Towards Soy Self-Sufficiency through Synergistic Application of Policies. Food Crops Science, 7 (1), pp.47-57

[18] Zakaria, Amar K.2010. Soybean Cultivation Development Policy Towards Self-Sufficiency Through Farmer Participation. Journal of Agricultural Policy Analysis. Volume 8 No.3