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Received on: April 05, 2020

Manuscript No.: 102493-JBS-ANSI

Submitted to: Journal of Biological Sciences

Title: Improvement Of Soybean Yield Through Selection Of Varieties and Improvement of Phosphorus Nutrient Availability With The Arbuscular Mycorrhizae Application

Dear St. Subaedah,

Thank you very much for submitting your above mentioned manuscript. Your paper has been assigned with an ID of 102493-JBS-ANSI. Please refer to this ID whenever you communicate with our Editorial Office in the future.

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Journal of Biological Sciences

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Dear St Subaedah,

We have received the following article for publication in Journal of Biological Sciences on April 05, 2020 and your good name is listed as co-author in this article.

Article Number:

102493-JBS-ANSI

Title:

Improvement Of Soybean Yield Through Selection Of Varieties and Improvement of Phosphorus Nutrient Availability With The Arbuscular Mycorrhizae Application

Author(s) Name:

St Subaedah, Netty S Said, Andi Ralle

Submitted to:

Journal of Biological Sciences

Corresponding Author:

St. Subaedah

Evaluation Report

Final Decision: Reconsider for Evaluation after Modifications and Clarifications

Article No.: 102493-JBS-ANSI Article Type: Research article

Table Available: 5 Tables cited: 5

Figures available: 2 Figures cited: 2

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7.	Abstract	<u>Do not explain results in conclusion section. Author is requested to conclude his main findings in 2-3 lines that what he has investigated. How this study proves</u>	

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8.	Keywords	Overall OK	
9.	Introduction	Overall OK	
10.	Materials and Methods	Overall OK	
11.	Results	Overall OK	
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18.	References	Overall OK	

Growth and Yield of Two Soybean Varieties by Phosphate Fertilization and Arbuscular Mycorrhizal Application

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LiveDNA: 62.25602*

Running title: *Growth and Yield of Two Soybean Varieties*

Corresponding author's : St. Subaedah, Departement Agrotechnology Universitas Muslim Indonesia, Makassar, Indonesia

Conflic Interest :

The authors have declared that no comflic interest exists.

Author's contribution:

St Subaedah/st.subaedah@umi.ac.id-Corresponding author-coordinating the implementation of research in the field-Coordinate the preparation of research reports.

Netty S Said/nettysyam@gmail.com-Co-author-Coordinate the maintenance of plants in the field-Coordinate data collection in the field-Coordinate the analysis of research data.

Andi Ralle/andira@umi.ac.id-Co-author-Coordinate phosphorus analysis in the laboratory-Coordinate data collection in the laboratory.

Abstract

Background and Objective: Soybean is one of the main food commodities in Indonesia with high protein content. The need for soybeans is increasing in line with increasing public awareness of high protein foods, while soybean production in Indonesia is still very low. This study aims to analyze the growth and yield of two soybean varieties to increase the availability of phosphorus nutrients with the application

of arbuscular mycorrhizae. **Materials and Methods:** The experiment was designed in the form of a Split-Split Plot Design. As the main plot is the treatment of varieties consisting of two types, namely: Anjasmoro and Gema varieties. As a subplot is mycorrhizal application consisting of two levels, namely without the application and mycorrhizal application. As sub-sub plots are phosphate fertilizers consisting of three levels, namely 50, 100 and 150 kg SP⁻³⁶ ha⁻¹. Of the three factors obtained 12 treatment combinations. **Results:** The results showed that the growth of soybean plants was influenced by the variety used, and the interaction between phosphate fertilization and mycorrhizal application. In the pod weight parameters showed that the use of Anjasmoro varieties with mycorrhoea application and fertilization of 100 kg SP₋₃₆ ha⁻¹ obtained pod weight. **Conclusion:** Application of arbuscular mycorrhizal can increased the availability of phosphorus up to 30%, and increased soybean production up to 21% higher than without mycorrhizal application. The use of Anjasmoro varieties obtained a production of 2.639 tons ha⁻¹ and higher than the Gema variety which only produced 1.937 tons ha⁻¹ [A1]

Keywords: Fertilization, soybean, arbuscular mycorrhizae, phosphorus, yield, gema variety, anjasmoro variety

INTRODUCTION

In Indonesia, soybean is a source of vegetable protein and is used as raw material for making tempeh and tofu, and is also used as animal feed [1]. Besides being rich in protein, soybean seeds also contain phosphorus, iron, calcium, vitamin B with complete amino acid

composition, so that the potential for human body growth. Soybeans also contain unsaturated acids that can prevent arterial sclerosis, which is hardening of the arteries ^[2].

The need for soybean is increasing from year to year in line with population growth and increasing public awareness of vegetable protein foods. While soybean production is still very low. This causes the high import of soybeans. In 2018, imports of soybean in Indonesia by 2.5 million tonnes ^[3].

Efforts to increase soybean production continue to be carried out, for example the use of superior varieties. Variety selection plays an important role in crop cultivation, because variety is the main key to increase production ^[4,5]. In addition to the selection of varieties, management of the growing environment must also be considered, because the potential high yield of seeds from superior varieties cannot be achieved if the environment is not supportive ^[6]. Soybean development is generally carried out in dry land which is faced with many problems including low soil fertility. Therefore it is necessary to improve soil fertility by fertilizing.

Among the three primary macro nutrients, phosphorus is one of the macro nutrients that often limits crop production and its availability is often problematic ^[7; 8]. Phosphate fertilization basically seeks to increase the availability of phosphate nutrients for plant growth and production. However, phosphate fertilization is not always directly proportional to the level of phosphate nutrient uptake by plants. In the soil, phosphorus is very easily fixed by other elements such as, Al, Fe, Ca, and Mg, so that phosphorus is not available for plants ^[9-11]. To increase the efficiency of P fertilization, one way that can be done is to work on a combination of P fertilization with the application of biological fertilizer ^[12].

Mycorrhiza is a type of biological fertilizer and is a fungus that lives in the soil and can be associated with plants^[13]. Mycorrhizal plants have the ability to absorb water and nutrients better because of hyphae threads from mycoriza, so that access and wider reach in exploiting nutrients in an area^[14,15]. External hyphae on mycorrhiza can absorb the phosphate element that is bound in the soil and become an element that is available to plants^[16-18]. The use of arbuscular mycorrhizae also increases the resistance of drought plants^[19].

Based on this description, a study was conducted to analyze the effect of varieties and increase the availability of P nutrients with the application of arbuscular mycorrhizae to an increase in soybean crop yields.

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Received on: April 05, 2020

Manuscript No.: 102493-JBS-ANSI

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Title: Improvement Of Soybean Yield Through Selection Of Varieties and Improvement of Phosphorus Nutrient Availability With The Arbuscular Mycorrhizae Application

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Dear Dr. St. Subaedah

This is with regard to your submitted manuscript, 102493-JBS-ANSI, titled Improvement Of Soybean Yield Through Selection Of Varieties and Improvement of Phosphorus Nutrient Availability With The Arbuscular Mycorrhizae Application, submitted to Journal of Biological Sciences on April 05, 2020 for consideration as a Research Article.

The article has been accepted for publication after revision. A Peer Review report is available online and you can access this report after log in to your account with User ID: st.subaedah@umi.ac.id.

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**Improvement Of Soybean Yield Through Selection Of Varieties and
Improvement of Phosphorus Nutrient Availability With The Arbuscular
Mycorrhizae Application**^[A2]

**Improvement Of Soybean Yield Through Selection Of Varieties and
Improvement of Phosphorus Availability With Mycorrhizae**

**Improvement Soybean Yield Through Selection of Varieties and
Improvement of Phosphorus Availability With Application Mycorrhizae**

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Corresponding author's e-mail: st.subaedah@umi.ac.id

LiveDNA: 62.25602*

Running title:^[A3]

Author's contribution:^[A4]

Conflict of interest:^[A5]

Abstract

Background and Objective: Soybean is one of the main food commodities in Indonesia with high protein content. The need for soybeans is increasing in line with increasing public awareness of high protein foods, while soybean production in Indonesia is still very low. This research was conducted with the aim of analyzing the increase in soybean crop yields by selecting varieties and increasing the availability of phosphorus nutrients with the application of arbuscular mycorrhizae. **Materials and Methods:** ~~This research was conducted in the form of an experiment in Takalar district, South Sulawesi, Indonesia.~~ The experiment was designed in the form of a Split-Split Plot Design. As the main plot is the treatment of varieties consisting of two types, namely: Anjasmoro and Gema varieties. As a subplot is mycorrhizal application consisting of two levels, namely without the application and mycorrhizal application. As sub-sub plots are phosphate fertilizers consisting of three levels, namely 50, 100 and 150 kg SP-36 ha⁻¹. Of the three factors obtained 12 treatment combinations. **Results:** The results showed that arbuscular mycorrhizal application can increase the availability of phosphorus up to 30%, and increased soybean production up to 21% higher than without mycorrhizal application. The use of Anjasmoro varieties obtained a production of 2.639 tons ha⁻¹ and higher than the Gema variety which only produced 1.937 tons ha⁻¹

Conclusion: [A6]

Keywords: Fertilization, soybean, arbuscular mycorrhizae, phosphat, yield, Gema variety, Anjasmoro.

INTRODUCTION^[A7]

In Indonesia, soybean is a source of vegetable protein and is used as raw material for making tempeh and tofu, and is also used as animal feed ^[1]. Besides being rich in protein, soybean seeds also contain phosphorus, iron, calcium, vitamin B with complete amino acid composition, so that the potential for human body growth. Soybeans also contain unsaturated acids that can prevent arterial sclerosis, which is hardening of the arteries ^[2].

The need for soybean is increasing from year to year in line with population growth and increasing public awareness of vegetable protein foods. While soybean production is still very low. This causes the high import of soybeans. In 2018, imports of soybean in Indonesia was 2.5 million tonnes ^[3].

Efforts to increase soybean production continue to be carried out, for example the use of superior varieties. Variety selection plays an important role in crop cultivation, because variety is the main key to increase production ^[4; 5]. In addition to the selection of varieties, management of the growing environment must also be considered, because the potential high yield of seeds from superior varieties cannot be achieved if the environment is not supportive ^[6]. Soybean development is generally carried out in dry land which is faced

with many problems including low soil fertility. Therefore it is necessary to improve soil fertility by fertilizing.

Among the three primary macro nutrients, phosphorus is one of the macro nutrients that often limits crop production and its availability is often problematic ^[7]. Phosphate fertilization basically seeks to increase the availability of phosphate nutrients for plant growth and production. However, phosphate fertilization is not always directly proportional to the level of phosphate nutrient uptake by plants. In the soil, phosphorus is very easily fixed by other elements such as, Al, Fe, Ca, and Mg, so that phosphorus is not available for plants ^[8,9]. To increase the efficiency of P fertilization, one way that can be done is to work on a combination of P fertilization with the application of biological fertilizer^[10].

Mycorrhiza is a type of biological fertilizer and is a fungus that lives in the soil and can be associated with plants^[11]. Mycorrhizal plants have the ability to absorb water and nutrients better because of hyphae threads from mycoriza, so that access and wider reach in exploiting nutrients in an area^[12,13]. External hyphae on mycorrhiza can absorb the phosphate element that is bound in the soil and become an element that is available to plants^[14]. The use of arbuscular mycorrhizae also increases the resistance of drought plants ^[15].

Based on this description, a study was conducted to analyze the effect of varieties and increase the availability of P nutrients with the application of arbuscular mycorrhizae to an increase in soybean crop yields.

MATERIAL AND METHODS

Study area: This research was conducted in the dry land of Takalar Regency, South Sulawesi, Indonesia. [A8] The planting material consists of Anjasmoro varieties, Gema, manure, mycorrhizae, urea, SP-36, KCl and insecticide. While the tools used include: hoes, hand tractors, scales, labels, meters, ovens and others.

Experimental procedure: This experiment was designed with a Split-split Plot Design. As the main plot is the treatment of varieties consisting of two types, namely:

V1: Anjasmoro Varieties

V2: Gema Varieties

As a sub-plot is the administration of mycorrhizae consisting of two levels, namely:

M1: without mycorrhizae

M2: mycorrhizal application (8 tons ha⁻¹)

As sub-sub plot is fertilization of phosphorus which consists of three levels, namely:

P1: 50 kg SP₋₃₆ ha⁻¹

P2: 100 kg SP₋₃₆ ha⁻¹

P3: 150 kg SP₋₃₆ ha⁻¹

Of the three factors, 12 treatment combinations were obtained and repeated three times to obtain 36 experimental unit units.

Implementation of the Experiment

The land used in the experiment was divided into three blocks as replications. Each block is divided into 2 main plots measuring 10 m x 3 m. The main plot was divided into two sub-plots measuring 4.5 x 3 m, then sub-plots were divided into three sub-plots measuring 1.5 x 3 m. The distance between the main plots is 1m and the distance between blocks is 1 m. Soybean seed planting is carried out with a distance of 40 cm between the rows and a distance of 20 cm in rows. SP₋₃₆ fertilization and mycorrhizae are given at the same time as planting with dosages in accordance with the provisions of the treatment, KCl fertilizing with a dose of 100 kg per hectare given at planting and fertilizing 100 kg per hectare of urea, given twice, namely at planting with 1/3 dose and 2/3 of the dose at the age of 30 days after planting.

Weeding is done manually at the age of 20 and 40 days after planting. Replanting crops and crop thinning are done if needed at the age of 2 weeks after planting.

The parameters observed in this study include: plant height, number of leaves, number of pods, pod weight per plant, weight of 100 seeds, weight of seeds per ha, and P-available in soil conducted at the end of the experiment.

RESULT AND DISCUSSION

Plant Height

The results of the analysis of plant height data at the age of 8 weeks after planting (WAP) showed that there was a significant interaction between the use of different varieties with application mycorrhizal. Likewise, the application of phosphorus fertilizer has a significant effect. The average height of the soybean crop in Table 1 [A9] indicated that the interaction between the use of varieties Gema with the use of mycorrhizal plants exhibit a high of 56.71 cm. In the treatment of phosphorus fertilization shows that the more the dose of phosphorus fertilizer is given up to a dose of 150 kg.ha⁻¹ the higher the soybean plants produced.

Number of Leaves

Observation of the number of leaves showed that there is a significant interaction effect between varieties and phosphorus fertilization. The average number of leaves in Table

2 showed that the Gema variety with 150 kg SP₋₃₆ ha⁻¹ fertilization has a greater number of leaves, 26.7 strands, and is significantly different from the interaction between Anjasmore varieties with the same dose.

Number of Pods per Plant

Number of pods per plant is presented in Figure 1^[A10], and indicated that Anjasmore varieties produce more pods compared with Gema varieties. This figure also shows that the application of mycorrhiza increased the number of pods in both Anjasmore and Gema varieties.

Pod Weight per Plant

The results of the analysis of pod weight per plant showed that there were significant interactions between different varieties, mycorrhizal application and phosphorus fertilization. Table 3 showed that the interaction between Anjasmore varieties with mycorrhoea application and fertilization phosphat of 100 kg SP₋₃₆ ha⁻¹ (V1M1P2) obtained the heaviest pod weight of 41.70 g and was significantly different from other interactions except with interactions between Anjasmore varieties with the use of mycorrhoea and fertilizing phosphorus 50 kg SP₋₃₆ ha⁻¹ (V1M1P1).

The Weight of 100 Seeds of Soybean

Observation of the weight of 100 bji showed that different varieties significantly affect the weight of 100 seeds. The average weight of 100 seeds in Table 4 showed that the Anjasmore variety has significantly heavier seeds (15.28 g) compared to the Gema variety (12.40 g).

Dry Seed Production per ha

The results of the analysis of the production of soybean dry seeds per ha indicated that differences in varieties and mycorrhizal applications have a significant effect. Dry seed

production per ha in Table 5 showed that the use of Anjasmoro varieties obtained higher production of 2.639 t.ha^{-1} and significantly different from the production of Gema varieties which only produced 1.937 t.ha^{-1} . In mycorrhizal application treatment showed that mycorrhizal application increased soybean production 21% compared without mycorrhizal application (mycorrhizal application obtained a production of 2.513 t.ha^{-1} , while without mycorrhiza only by 2.080 t. ha^{-1})

P-available in soil

The results of the analysis of P-available in the soil indicated that mycorrhizal application increases P nutrient availability compared to phosphate fertilization without mycorrhiza. The results of this analysis also showed that the availability of the highest phosphate nutrition is 30% with low dose phosphate fertilization ($50 \text{ kg SP-36 ha}^{-1}$).

Discussion

Different varieties, phosphate fertilization and mycorrhizal application affect the growth and production of soybean plants. Different varieties showed different plant growth and production. These results are in line with the findings of [16; 17] who found that plant growth and production is influenced by the variety used. In this study it was also found that the Gema variety showed the highest plants and the number of leaves more than the use of the Anjasmoro variety. This is related to the growth form of the Gema variety which has vertical growth characteristics with narrower but thicker leaves, while Anjasmoro variety has wider growth with wider leaves. The parameter weights of 100 seeds indicated that the Anjasmoro variety has a weight of 100 seeds which is heavier than the Gema variety. Anjasmoro varieties are large/heavy seeded soybean varieties^[18].

Mycorrhizal application showed a higher number of pods, as well as dry seed production per hectare which is markedly greater by 21% than without application

mycorrhizal (Figure 1 and Table 5). This is in line with the findings of ^[19] who suggested that mycorrhizal inoculation increased canopy biomass and increased grain yield by 40% compared without mycorrhizal inoculation.

Production component parameters (pod weight) showed that the Anjasmore variety with 100 kg SP₃₆ fertilizer per ha accompanied by mycorrhizal application obtained the heaviest pod weight. Likewise the dry seed production parameters showed that the Anjasmore variety produces a significantly higher production of 2.639 tons. This is in line with the findings of ^[20] who suggested that crop production is positively correlated with the production component. Varieties play an important role in determining the growth and level of plant production achieved, because the genetic potential of each variety is different. This result is in line with the results of the study of ^[21] who analyzed several soybean varieties, and suggested that the use of Anjasmore varieties obtained higher results compared to other varieties.

Increased yield with the use of Anjasmore varieties and mycorrhizal applications is supported by an increase in the availability of phosphorus. The highest increase in phosphorus availability was 30% in low dose P fertilization (Figure 2). ^[A11] This is in line with the results of the study of ^[22; 23] who found that mycorrhizal activity in increasing the availability of phosphate nutrients was more effective in the use of low-dose P fertilizer. Furthermore ^[24; 23] suggested that arbuscular mycorrhiza increases the activity of acid phosphatase in the soil, so that P-organic compounds in the soil can become available to plants after being hydrolyzed by the phosphatase enzyme.

Increased availability of P nutrients, allows absorption of P nutrients to run smoothly, and this is very beneficial for the development of soybean in dry land, which is faced with the problem of low soil fertility, while phosphorus is needed by soybean plants, both for the formation and activity of root nodules and plant needs ^[25]. The results of ^[26] showed that

increasing the availability of P nutrients will increase soybean production. ^[27] suggest that in the face of a resource shortage crisis, the application of arbuscular mycorrhizae can play a key role in solving the problem of phosphate availability and increasing fertilizing efficiency, especially P fertilizer.

CONCLUSION

Mycorrhizal application increased the availability of phosphorus nutrients compared without mycorrhizal application. Increase the availability of phosphorus nutrients up to 30% by applying 50 kg SP-36.ha⁻¹ phosphate fertilizer. The use of Anjasmoro varieties obtained higher production at 2.639 tons.ha⁻¹. Mycorrhizal application obtained 21% higher production compared without mycorrhizal application.

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Thank you to the Ministry of Research and Technology of Higher Education who has provided financial assistance through the University Flagship Research Scheme, 2019, also to BPTP Sudiang who provided genetic material for testing. Thank you also to LP2S UMI who facilitated this research, so that they could get funding^[A12] from the Ministry of Research and Technology of Higher Education.

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Growth and Yield of Two Soybean Varieties by Phosphate Fertilization and Arbuscular Mycorrhizal Application

St. Subaedah, Netty S.Said, Andi Ralle

Departement Agrotechnology Universitas Muslim Indonesia

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LiveDNA: 62.25602*

Running title: *Growth and Yield of Two Soybean Varieties*

Corresponding author's : St. Subaedah, Departement Agrotechnology Universitas Muslim
Indonesia, Makassar, Indonesia

Conflic Interest :

The authors have declared that no comflic interest exists.

Author's contribution:

St Subaedah/st.subaedah@umi.ac.id-Corresponding author-coordinating the implementation
of research in the field-Coordinate the preparation of research reports.

Netty S Said/nettysyam@gmail.com-Co-author-Coordinate the maintenance of plants in the
field-Coordinate data collection in the field-Coordinate the analysis of research data.

Andi Ralle/andira@umi.ac.id-Co-author-Coordinate phosphorus analysis in the
laboratory-Coordinate data collection in the laboratory.

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Conflic Interest :

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Author's contribution:

St Subaedah/st.subaedah@umi.ac.id-Corresponding author-coordinating the implementation of research in the field-Coordinate the preparation of research reports.

Netty S Said/nettysyam@gmail.com-Co-author-Coordinate the maintenance of plants in the field-Coordinate data collection in the field-Coordinate the analysis of research data.

Andi Ralle/andira@umi.ac.id-Co-author-Coordinate phosphorus analysis in the laboratory-Coordinate data collection in the laboratory.

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Dr. St. Subaedah,
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Subject: Acceptance Letter for Article No. 102493-JBS-ANSI

It's a great pleasure for us to inform you that below mentioned manuscript has been accepted for publication in Journal of Biological Sciences as Research Article on the recommendation of the reviewers.

Title: Growth and Yield of Two Soybean Varieties by Phosphate Fertilization and Mycorrhizal Application

Author's Name: St Subaedah, Netty S Said and Andi Ralle

Receiving Date: April 05, 2020

Accepted on: June 03, 2020

Regards



M. Imran Pasha
Publication Manager

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