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St. Subaedah, Netty S. Said, and Andi Ralle
Faculty of Agriculture, Universitas Muslim Indonesia Makassar

Email: *st.subaedah@umi.ac.id*

Abstract. Soybean demand from year to year is increasing in line with an increase in population and increasing people's understanding of nutritious food, while soybean production is still very low. Therefore, various efforts continue to be made to increase soybean production, for example by selecting high-yielding varieties and improving soil fertility. This research was conducted with the aim of increasing soybean crop production by selecting appropriate varieties and improving soil fertility by application mycorrhizal biofertilizers. This research was conducted in the form of experiments in the district of Takalar, South Sulawesi, which took place from April to July 2019. The experiment was designed with the Split Plot Design. As the main plot is the treatment of varieties consisting of 3 types, namely: Anjasmoro varieties, Argomulyo varieties and Gema. As a subplot is the provision of mycorrhizae consisting of two levels, namely without the application of mycorrhizae and mycorrhizal applications. From these two factors, 6 treatment combinations were obtained and were repeated three times, so that 18 experimental units were obtained. The results showed that there was an effect of varieties treatment and mycorrhizal application on plant growth and soybean crop production. The use of Gema varieties and their interactions with the application of mycorrhizae produce the highest soybean plants. The parameters of production components and soybean production indicate that mycorrhizal application produces the highest number of productive branches, while the use of Anjasmoro and Argomulyo varieties produces the highest number of pods, pod weight and dry seed production per ha.

1. Introduction

Soybean has become an important part of the diet of most people in Indonesia. both in urban and rural areas. The average level of soybean consumption is 8.12 kg/capita / year [1]. Therefore, soybean needs to be available in sufficient quantities for the population whose numbers continue to increase from year to year. Soybean production in Indonesia in 2017 is 538.728 tons while soybean needs are more than 2 million tons. This is why soybean imports cannot be avoided, where soybean imports in 2017 reached 2.75 million tons [2]. Efforts to increase production continue to be pursued, both through extensification and intensification. Increased production through intensification is done through improved cultivation techniques, for example, the selection of varieties.

The use of superior varieties is one technological innovation that can increase soybean production. In the period 1918 to 2015, there were 83 soybean varieties that had been released and were attempted to be distributed to farmers. The variety of superior soybean varieties increases the choice and fulfilment of soybean user preferences. However, the release of improved varieties carried out did not show a sharp increase in national average soybean production that only moved from 1.0-1.5 t/ha [3].

Therefore in addition to the selection of varieties. It also needs to be balanced with improvements in other cultivation techniques, for example by improving soil fertility.

Management of soil fertility can be done by fertilizing which aims to increase nutrients for plant growth and production. One type of fertilizer that has a good effect on plant growth is mycorrhizal biological fertilizer. Mycorrhiza is a mutual symbiosis between fungi and plant roots. One type of mycorrhizae is Arbuscular Mycorrhizal Fungi (AMF) which is symbiotic with most land plants in almost all terrestrial ecosystems [4]. The use of AMF has a number of beneficial effects on plants that can be symbiotic, such as suppressing the need for phosphate [5], also increasing drought resistance [6], increasing plant resistance to soil salinity stress [7].

Arbuscular mycorrhiza that infects the root system of the host plant which will produce hyphae intensively, so that plants with mycorrhiza will be able to increase the absorption capacity of nutrients and water [8; 9]. Based on this description, a study was conducted aimed at analyzing the growth and production response of various soybean varieties with the mycorrhizal application.

2. Material and Methods

This research was carried out in the form of an experiment (experiment) in Takalar Regency which lasted from April to July 2019. The planting material consisted of soybean seeds of Anjasmoro, Agromulyo, Gema, Mycorrhizal, urea, KCl and SP-36 fertilizers. While the tools used included: hoes, hand tractors, scales, labels, meters, ovens and others.

This experiment was designed with a Split Plot Design. As the main plot is a soybean variety consisting of three varieties, namely:

V1: Anjasmoro variety
V2: Argomulyo variety
V3: Gema variety

As a subplot is mycorrhizal application consisting of two levels, namely:

M0: without mycorrhizal application
M1: mycorrhizal application of 8 tons/ha

From these two factors. 6 treatment combinations were obtained and repeated three times to obtain 18 experimental units. Land preparation begins with ploughing the land. then followed by rooting and levelling. The cultivated land is then divided into three blocks with a distance between each 1 m block. Each block is divided into three main plots, each measuring 4 m x 2 m. Then the main plot is divided into two sub-plots measuring 2 m x 2 m. The distance between the main plots is 1 m and the distance between 0.5 m plots. Application biological fertilizer (mycorrhizae) is carried out in accordance with the provisions of the treatment carried out before planting. Soybean seed planting is carried out with a distance of 40 cm in row spacing and 20 cm in row spacing. Fertilization SP-36 and KCl with doses of 100 kg per hectare given at the time of planting is 1 week after planting, and fertilizing 100 kg per hectare of urea is given twice, namely at planting time of 1 week at 1/2 dose and 1/2 dose at 30 days after planting. Weeding is done manually at the age of 20 and 40 days after planting. The observed variables included: plant height, number of productive branches, number of pods per plant, pod weight per plot and seed production per plot.

3. Result and Discussion

3.1. Plant height

The results of the analysis of plant height data at the age of 8 weeks after planting (WAP) showed that the treatment of various varieties and mycorrhizal applications significantly affected. Based on the LSD test results level of 0.05 in Table 1 shows that the Gema variety soybean plants with mycorrhiza application produced the highest plants that are 56.05 cm and significantly different from the height of the Anjasmoro c variety plants that were given mycorrhizae that only produce plants with a height of 48.30 cm.

Table 1. Effect of varieties and mycorrhizal application on soybean height at 8 WAP (cm)

Variety	*Mycorrhizae*		*LSD 0.05*
	Without Mycorrhizae	*Application Mycorrhizae*	
1: Anjasmoro	52.32 ax	48.30 bx	4.07
2: Argomulyo	49.44 ax	47.81 ax	
3: Gema	52.20 ax	56.05 ay	

Note: average values followed by the same letters in rows (a. b) and columns (x. y) are not significantly different based on the LSD level of 0.05

3.2. Number of Productive Branches

Observations on the number of productive branches show that the application of mycorrhizal application has a significant effect. but differences in varieties and interactions between the two have not shown a significant effect on the number of productive branches. The average number of productive branches presented in Table 2 shows that mycorrhizal applications produce more productive branches. namely, 24.33 branches and are significantly different from those without mycorrhizal application.

Table 2. The average number of productive branches of soybean in various varieties and mycorrhizal applications

Variety	*Mycorrhizae*		***Average***
	Without Mycorrhizae	*Application Mycorrhizae*	
1: Anjasmoro	22.09	28.57	25.33
2: Argomulyo	23.13	26.31	24.72
3: Gema	15.93	18.13	17.03
Average	20.39 b	24.33 a	
LSD 0.05	3.87		

Note: average values followed by the same letters in rows are not significantly different based on the LSD level of 0.05

3.3. Number of Pods

The results of the calculation of the number of soybean pods showed that the various treatment and mycorrhizal application had a significant effect. Based on the LSD 0.05 follow-up test results in Table 3 shows that the highest number of pods obtained in Anjasmoro variety was 81.70 and significantly different from the number of pods produced by Gema variety but not significantly different from the number of pods produced by Argomulyo varieties.

Table 3. The average number of soybean pods in various varieties and mycorrhizal applications

Variety	*Mycorrhizae*		***Average***	***LSD 0.05***
	Without Mycorrhizae	*Application Mycorrhizae*		
1: Anjasmoro	71.38	92.01	81.70 a	31.33
2: Argomulyo	63.20	75.05	69.12 a	
3: Gema	33.93	47.05	40.49 b	
verage	56.17 b	71.37 a		
SD 0.05	14.22			

Note: average values followed by the same letters in rows and columns are not significantly different based on the LSD level of 0.05

3.4. Pod Weight

The results of data analysis showed that the various treatment and mycorrhizal application had a significant effect on the weight of the bean pods per plant. but the interaction between the two had not shown any significant effect. Average soybean pod weight of LSD test level of 0.05 presented in Table 4 shows that the heaviest pod weight obtained in Anjasmoro variety is 34.84 g followed by argomulyo variety which is 34.59 g and is significantly different from pod weight produced by variety Echo is 13.65 g.

Table 4. Effect of various varieties and mycorrhizal applications on soybean pod weight per plant (g)

Variety	*Mycorrhizae*		*verage*	*LSD 0.05*
	Without Mycorrhizae	*Application Mycorrhizae*		
1: Anjasmoro	28.12	41.56	34.84 a	9.70
2: Argomulyo	30.30	38.89	34.59 a	
3: Gema	11.84	15.47	13.65 b	
Average	23.42 a	31.97 a		
LSD 0.05	8.49			

Note: average values followed by the same letters in rows and columns are not significantly different based on the LSD level of 0.05

3.5. Soybean Pod Weight per plot

The results of data analysis showed that the treatment of varieties significantly affected the weight of soybean pods per plot. The average soybean pod weight of 0.05 LSD test results in Table 5 shows that the heaviest pod weight per plot was obtained in the Anjasmoro variety of 415.66 g and significantly different from the pod weight produced by Gema variety of 279.17 g, but not different evident with the weight of pods produced by Argomulyo varieties.

Table 5. Effect of various varieties and mycorrhizal applications on soybean pod weight per plot

Variety	*Mycorrhizae*		***verage***	***LSD 0.05***
	Without Mycorrhizae	*Application Mycorrhizae*		
1: Anjasmoro	398.38	432.95	415.66 a	61.40
2: Argomulyo	371.65	407.26	389.45 a	
3: Gema	266.18	292.16	279.17 b	
verage	345.40	377.46		

Note: average values followed by the same letters in columns are not significantly different based on the LSD level of 0.05

3.6. Soybean Seed Weight per plot

Data from the analysis of seed weight per plot (tile area 0.8 m2) showed that the treatment of varieties significantly affected the weight of soybean seeds per plot. LSD test results of 0.05 level in Table 6 show that the weight of soybean seeds per plot was obtained in the Anjasmoro variety as many as 264.26 g and significantly different from the weight of seeds produced by the Gema variety which is 179.59 g, but not significantly different from seed weight produced by Argomulyo varieties.

Table 6. Effect of various varieties and mycorrhizal applications on soybean seed weights per plot (g)

Variety	*Mycorrhizae*		***verage***	***.SD 0.05***
	Vithout Mycorrhizae	*Application Mycorrhizae*		
1: Anjasmoro	257.73	270.78	264.26 a	59.43
2: Argomulyo	244.25	262.97	253.61 a	
3: Gema	181.40	177.77	179.59 b	
Average	227.79	237.17		

Note: average values followed by the same letters in columns are not significantly different based on the LSD level of 0.05

3.7. Dry Seed Production per ha

The results of the analysis of dry seed weight per ha showed that the treatment of varieties had a significant effect. Based on BNT follow-up tests of the 0.05 level presented in Table 7, it can be seen that the Argomulyo variety obtained the driest seed production, which is 2.88 tons/ha and significantly different from soybean production obtained by the Gema variety which is only 2.10 tons/ha but not significantly different from the seed production produced by Anjasmoro varieties.

Table 7. Production of dried beans per ha (t / ha) from various varieties and mycorrhizal applications

Variety	*Mycorrhizae*		***verage***	***.SD 0.05***
	Vithout Mycorrhizae	*Application Mycorrhizae*		
1: Anjasmoro	2.66	2.98	2.82 ab	0.75
2: Argomulyo	2.78	2.98	2.88 a	
3: Gema	2.10	2.09	2.10 b	
verage	2.51	2.68		

3.8. Discussion

The results of the data analysis showed that the growth of soybean plants was influenced by the variety used and the use of mycorrhizal biofertilizers. This can be seen from the plant height parameters which indicate that the Gema variety of soybean plants with mycorrhizae application produces the highest plants that are 56.05 cm (Table 1). Plant growth is an interaction between genetic factors and environmental factors [10], therefore in the development of plants how this genetic potential can be maximized with the support of appropriate cultivation technology, for example improving soil fertility with the use of biological fertilizers (mycorrhizae) so existing genetic potential can emerge.

The effect of varieties on the production component and soybean crop production also shows a significant effect. Varieties play an important role in determining the level of crop production because to achieve high yields is largely determined by their genetic potential. [11] which showed that different varieties significantly affected soybean crop production. Likewise, the results of research by [12] showed that differences in the genotype of corn plants will affect the level of corn crop production. The results of this study indicate that the varieties of Argomulyo and Anjasmoro showed the best results compared to the Gema variety shown by the parameters of the number of productive branches, number of pods, pod weight and seed weight per plot, and dry seed production per ha which were significantly higher. This is consistent with the results of research by [13] who reported that Anjasmoro varieties showed higher results compared to other varieties. These varieties have a variety of potential yield characteristics, harvest age, seed size, seed coat color, resistance to biotic/abiotic stresses, and adaptation areas.

The mycorrhizal application showed that the number of productive branches, number of pods and soybean pod weight was significantly better by giving mycorrhiza. These results are in line with the findings of [14] and [15] who reported that the arbuscular mycorrhiza produced was able to increase the growth and yield of soybean. The good effect of mycorrhizae on plant growth was also reported by [16] who reported that mycorrhizal application in rice plants increased production by up to 40%, while the results research of [17] reported that the application of mycorrhizae in Jatropha plants produced a real growth better than without an application.

The ability of mycorrhizae to improve plant growth and production is due to plants that are symbiotic with mycorrhiza will form a braided hip that increases the capacity of roots in nutrient absorption. This is consistent with the results of research by [18] who found that the application of FMA was able to increase the pH, P-available and CEC compared to without the application of FMA. Likewise, the results of research by [19] reported that mycorrhizal application increased levels of N, P, K, organic matter compared without application.

4. Conclusion

1. The use of Gema varieties with mycorrhizal application produced the highest growth of soybean plants.
2. Application mycorrhizal generate productive branch number and the highest number of pods and pod weighs heaviest.
3. Using Anjasmoro and Argomulyo varieties produced the highest number of pods, pod weights and seed weights.

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References

[1] Sudaryanto, T., and D. K.S Swastika. 2007. Soybean Economy in Indonesia, *In Soybean*, Production and Development Techniques. Agricultural Research and Development Agency. Center for Research and Development of Food Crops.
[2] BPS. 2018. Statistics of Indonesia. http://www.bps.go.id
[3] Susanto, G.W.A., and N. Nugrahaeni, 2018. Introduction and Characteristics of Soybean Superior Varieties. http://balitkabi.litbang.pertanian.go.id/wp-content/uploads/ *2018/03/bunga*.
[4] Smith S.E, D. J. Read. 2008. Mycorrhizal symbiosis. Third Edition. New York (USA): *Academic Press.*
[5] Rivana, E., N.P. Indriani, L. Khairani. 2016. Effect of Phosphorus Fertilization and Inoculation of Mikoriza Arbuskula (FMA) Fungi on Growth and Sorghum Production (*Sorghum bicolor* L.*). J. Ilmu Ternak* **16** (1): 46-53.
[6] Barzanal, G., R.Arocal, J.A. Pazl, F. Chaumont, M.C.M. Ballesta, M. Carvajal, J.M. R. Lozano. 2012. Arbuscular mycorrhizal symbiosis increases relative apoplastic water flow in roots of the host plant under both well-watered and drought stress conditions. *Ann Bot* **109** (5): 1009-1017.
[7] Damaiyanti, D.R.R., N.Aini, R. Soelistyono. 2015. Effects of arbuscular mycorrhiza inoculation on growth and yield of tomato (Lycopersicum esculentumMill) under salinity stress. *J. Of Degraded and Mining Lands Management,* **3** (1):447-452
[8] Buechel, T. and E. Bloodnick. 2016. Mycorrhizae: Description of Types, Benefits and Uses. Plant Healt. April 2016 GPNMAG.COM.
[9] Talanca, H. 2010. Status of Arbuscular Vesicular Mycorrhizal Fungi (VMF) in Plants. *In Prosiding Pekan Serealia Nasional, Balai Pnelitian Tanaman Serealia, Maros, 353-357*
[10] Gardner, F.P., R.B. Pearce and R.L. Mitchell. 2010. Physiology of Crop Plant. *Scientific Publisher. India.*
[11] Ramteke, R. and P. Murlidharan (2012). Characterization of soybean (Glycine max) varieties as per DUS guidelines. *Indian Journal of Agricultural Sciences* **82** (7):572-577
[12] Subaedah, S., S. Numba, dan Saida. 2018. Growth and Yield Performance of Candidates Hybrid Maize Genotypes for Early Harvest Trait in Dry Land. *J. Agron. Indonesia*, **46** (2):169-174.
[13] Marliah, A., T. Hidayat dan M. Husna. 2012. Pengaruh Varietas dan Jarak Tanam terhadap Pertumbuhan Kedelai (*Glycine max* (L.) Merrill. *Jurnal Agrista,* **16** (1): 22-28.
[14] Sasli, I., A. Ruliansyah. 2012. Pemanfaataan Mikoriza Arbuskula Spesifik Lokasi untuk Pemupukan pada Tanaman jagung di Lahan Gambut. *J. Agrovigor* **5** (2): 65-7
[15] Sasli, I. 2013. Respon Tanaman Kedelai terhadap pupuk hayati mikoriza arbuskula hasil rekayasa spesifik gambut. *J. Agrivigor* **6** (1):73-80.
[16] Cui, X.C., J. L. Hu, X. G. Lin, F. Y. Wang, R. R. Chen, J. H. Wang and J. G. Zhu. 2013. Arbuscular Mycorrhizal Fungi Alleviate Ozone Stress on Nitrogen Nutrition of Field Wheat. *J. Agr. Sci. Tech.* **15**: 1043-1052.
[17] Subaedah, St. 2007. Aplikasi mikoriza terhadap ketersedian unsur hara fosfor dan pengaruhnya terhadap pertumbuhan bibit jarak pagar (*Jatropha curcas*). *J. Agrivigor 6(2)1:74-177.*
[18] Nurmasyitah, Syafruddin, dan M. Sayuthi. 2013. Pengaruh jenis tanah dan dosis Mikoriza Arbuskular pada tanaman kedelai terhadap sifat kimia tanah. *Jurnal Agrista* . **17**(3):251-261.
[19] Astiko, W., I.R. Sastrahidayat, S. Djauhari dan A. Muhibuddin. 2012. Aplikasi pupuk organik berbasis mikoriza untuk meningkatkan hasil kedelai di daerah semi arid tropis Lombok Utara. *Buana Saind* **12** (1):15-20.