JoSSEd
Journal of Science and Science Education
ISSN: 2774-1869 eISSN: 2774-2105

Research Paper

The Effect of Organic and Inorganic Fertilizer Application on Soybeans Growth and Yield (*Glycine max L. Merril*)

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DOI: 10.29303/jossed.v4i1.3340

Article Info
Received: February 15, 2023
Revised: April 25, 2023
Accepted: April 28, 2023
Published: April 30, 2023

Abstract: A field experiment was conducted to assess the effect of petroganic organic and inorganic fertilizer application aimed to increase soybeans productions in dry land. This experiment is carried out in Keloka, Batujai village, Central Lombok. The experiment consists of two factors using splitplot design, organic fertilizer as main plot with two level which is the application 20 tons/ha of organic fertilizer (petroganic) and without application of organic fertilizer. Compound inorganic fertilization as sub-plot which consists of five levels, they are without phonska (control), 25%, 50%, 75%, and 100% NPK recommendation. The results of the experiment showed that there is no interaction between organic with inorganic fertilizer to the soybeans yield, but both organic fertilizer and inorganic fertilizer gave different effect to the fresh and dry weight, 100 seed weight and yield. Inorganic 50% NPK recommendation fertilization is the best in increasing the fresh weight (83,30 kg/plot), dry weight (64,49 kg/plot), 100 seed weight (42,75 g) and yield (4,55 kg/plot) which is equal to 3,16 tons/ha.

Keywords: Soybeans; Inorganic fertilizer; Organic fertilizer

Citation: Watimena, S.F. (2023). The Effect of Organic and Inorganic Fertilizer Application on Soybeans Growth and Yield (Glycine max L. Merril). *Journal of Science and Science Education*, *4*(1), 65–70. https://doi.org/10.29303/jossed.v4i1.3340

INTRODUCTION

Soybean (*Glycine max (L) Merril*) is a legume crop that can fill and increase nutrition for people (Ridwan *et al*., 2017). Protein content of soybean could reach 40% in comparison with other kind of legume that could only reach around 20-25% (Winarsi, 2010). Soybeans' demand in Indonesia is increasing along with the increase of populations (Marliah *et al*, 2012). This can be seen from the rate of soybeans import that keeps increasing by years. It even reaches 2.67 million tons in 2017, meanwhile the soybean production until 2017 only reach 538,728 tons.

The low rate of soybeans production both in national and West Nusa Tenggara region is affected by some factors; the usage of quality seeds factor/ the plant factor, low fertility of the soil, and climate factor. Other than that, the narrow state of the field also become the factor in the low rate of soybeans production.

Several attempts in increasing the domestic productivity rate have been done by the government which is called Pajale Special Attempt Program. This attempt is used with intercropping pattern, seed assistance, tool assistance, and machine assistance, and the use of sub optimal fields. Through this program, self-sufficiency of rice and corn that the government has planned has been reached, while the government is still trying to reach self-sufficiency in soybean commodity.

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West Nusa Tenggara is one of the provinces in Indonesia that has dry land reaching 1,814,340 ha (84.19% of total region) and approximately 330,069 ha has potential for crop field and spread out in each district (Suwardji, 2013). Dry land has a low fertility rate, especially in a soil affected by erosion so that the tillage layer becomes thin and organic matter decreased.

To increase the low fertility of soil in dryland areas, the effort of fertilization can be used. The fertilizer that can be used is organic fertilizer (cattle waste, compost, bokashi, petroganic) and inorganic fertilizer or chemical such as sole fertilizer (urea, SP-36, KCl) or compound fertilizer (NPK). Petroganic fertilizer has advantage in high C-Organic rate, granular, safe, environmentally friendly (free pathogen) and free from seed and weed. The petroganic's water content is low and could be efficient in transport and storage. Inorganic fertilizer can be used to supply 3 nutrients: nitrogen, phosphor, and potassium with a certain ratio. Balanced fertilization is hoped to give a recommendation soybeans cultivation technology that could produce soybeans in above average rate of Biosoy variety soybeans 1 that is 2.71 tons/ha (Kepmentan, 2018).

Based on the problems above and in order to accelerate soybeans self-sufficiency in Indonesia, this research about the effect of organic and inorganic fertilization to soybeans cultivation in dry lands becomes an important thing to do.

METHOD

The method used in this research is an experimental method with plot trial on field. The experiment is carried out in Keloka, Batujai Village, Praya sub-district, Central Lombok. Soybean variety used is Biosoy 1, organic fertilizer (granule shaped petroganic), and NPK compound (phonska).

Trial consists of two factors designed with split plot design, which are organic and inorganic fertilization. Organic fertilizer as the main plot consists of two levels: organic fertilizer (petroganic) with a dose of 20 ton/ha and without organic fertilizer. Inorganic fertilizer NPK (phonska) treatment as sub-plot consisting five levels, they are without NPK fertilization, 25%, 50%, 75%, and 100 % NPK fertilizer recommendation. Every treatment is repeated four times so that there are 40 unit.

Tillage was not applied in this experiment. The soil was just layered with straws (leftover from rice harvest) and application of decomposer. After it is done, the experiment plots were made as many as 40 plots, with the size of 14.4 m^2 each. Planting holes were made with distanced 40 cm x 20 cm, and the depth of each hole approximately 3-4 cm, three seeds were placed in each hole.

At planting, the soybeans were not watered because it still using the humidity of the soils after rice harvest. The critical period of soybeans towards drought began in flower formation until the seed filling (reproductive phase). Soil irrigation followed the irrigation pattern that has been done in the location, which is once a month. Organic fertilizer is given at a dose of 20 tons/ha (equivalent to 240 grams/planting hole) at the time of planting. Organic fertilizer is used to cover planting hole that has been filled with 3 soybean seeds.

Inorganic fertilizer (phonska, SP36, KCl) application is carried out according to fertilizer recommendation N, P, and K for soybeans that is 25 kg Urea/ha, 150 kg SP36/ha and 100 kg KCl/ha (Musaddad, 2008). Based on calculations obtained the amount of compound fertilizer needs (phonska) is 108 grams/plot, SP36 171 grams/plot, and KCl 111.6 grams/plot, this dose is a 100% recommended dose. So, for a dose of 75% recommendation, 50% recommendation, 25% recommendation adjusted based on the weight of fertilizer from 100% recommendation Fertilization is done once, that is on 14 DAS. Thinning was done in 14 DAS (day after showing) by removing the plants that did not grow well or abnormal, it left two soybeans plants per planting holes. Weeding was done manually. The intensity of weeding depends on the growth rate of the weeds in the planting area. The first weeding was done on 15 DAS and the second weeding was done on 40 DAS. Harvesting is done when most of the leaves already turned to yellow, fell, yellow pods or brown and fragile.

Observation parameters

Fresh and dry matter weight (kg). The observations were done after the harvest by measuring the fresh weight using digital scale. Next for the dry weight, the pods of the soybeans that have been harvested were separated by threshing it out and dried. The drying was done in the drying floor for two or three days, and measured until the constant weight was found. The weight of 100 soybeans seed. The weight of 100 soybeans seeds was obtained by picking up 100 beans randomly for each treatment and then weighted, and the random 100 beans picking were repeated for four times. The yield per plot. The yield per plot was

obtained by taking all the soybeans seeds and measured them. The yield per plot was depended on how many seed were formed per experiment plots.

Data Analysis

All the data were analyzed using Analysis of Variance (ANOVA) with Genstat Program 12.1, the different between means were analysed with HSD on 5% level.

RESULT AND DISCUSSION

Soil Characteristic

To understand the condition and characteristic of the experiment area's soil, soil sample was taken and was analyzed in Mataram University Faculty of Agriculture's Soil Laboratory. For pH, C-organic (%), N-total (%), P-available (ppm), K-switched (meq%) and Cation Exchange Capacity (CEC, meq%).

The result from the laboratory for the soil's characteristic (Table 1) shows that pH rate of the soil (7.45) is neutral, with the content of P-available and K-switched were in a very high criteria (22.64 ppm and 2.80 (meq%), and Cation Exchange Capacity (CEC) were in a high criteria of 26.54 meq%. But the content of C-organic and N-total were in the very low criteria (0.62% and 0.09%). Based on the data above, it can be concluded that the soil characteristic for the research area was appropriate for soybeans commodity (Permentan, 2013). In which the pH rate is appropriate (S1 class) for the soybeans (pH 5.5 – 7.5), thus the content of P-available, K-switched, and CEC are very appropriate (S1 class) and attempts to increase the content of C-organic and N-total were needed (S3 class). The content of C-organic was less than 2% which made the soil could not provide enough nutrition, so that fertilization was highly needed. With that in mind, the soil in the area was needed to be fertilized using Petroganic. Petroganic fertilization has the advantage in bloating and nourishing the soil, increasing the storage and the absorption abilities, enriching the macro and micro nutrients, high C-organic contents, perfect for all kind of plants, safe and environmentally friendly.

Table 1. Soil Characteristics

Soil characteristics	Value	Criteria
pH H_2O	7.45	Neutral
N-total (%)	0.09	Very Low
P-available Bray (ppm)	22.64	Very High
K-switched (meq%)	2.80	Very High
C-organic	0.62	Very Low
CEC (meq%)	26.53	High

Description: The analysis was done in Soil Science Laboratory, Faculty of Agriculture, Mataram University

Fresh and Dry Matter Weight

Petroganic and Phonska fertilization affected the fresh and dry matter weight of the plants. The result showed that there is no real different interaction between Petroganic and NPK fertilization towards the fresh and dry weight, but each of the treatments, Petroganic and NPK fertilization showed significant effect on fresh and dry matter weight.

Table 2. Fresh and Dry Matter Weight

Treatment	Weight (kg/plot)	
	Fresh	Dry matter
Organic Fertilizer:		
Without petroganic	53a	46.83a
Petroganic (20 ton/ha)	82.80b*)	66.51b
HSD 5%	19.71	12.22
Phonska Fertilizer:		
Control (without NPK)	47.70a	45.70a
25% recommendation	76.30bc	62.24cd
50% recommendation	83.30c	64.49d
75% recommendation	69.80bc	58.11c
100% recommendation	62.30b	52.82b
HSD 5%	14.35	5.17

Descriptions: *) The numbers that followed the same letter in the same column is different with the real-time trial of HSD 5%

The data on Table 2 showed that Phonska fertilization on 50% recommendation gave a high mark to the fresh and dry matter weight. In accordance to organic fertilization, showed the increased of fresh and dry weight in real time 56.23% and 42.02% each that the application of organic fertilizer with the dose of 20 tons/ha, in contrast with the plot without organic fertilizer. This in accordance with Suarsana, *et al*. (2018), where the increase of petroganic dose to 8 tons/ha gave a higher dry and wet matter (10% and 8.8%) compared with 4 tons/ha dose of petroganic.

Phonska fertilization can increase the growth rate especially in N and P macro nutrient which is an important nutrient since their existence can manage the biomass and the plant's growth. N nutrient is very important for the chlorophyll/green leaf, since it will make the plants healthier, increase the rate of photosynthesis, stimulate the growth vegetative especially in leaves and stems that makes the soybeans plants higher and bigger stem. Meanwhile the P nutrient roles in managing the plant adventitious roots which will increase the availability of the nutrients by increasing the soil exploration from the P absorptive surface of the roots and dissolution systems (Nemadodzi *et al*., 2017).

Hundred Seed Weight

The results showed that no interaction between petroganic and phonska fertilization. Self-inorganic and organic fertilization gave different effects to the weight of 100 beans and yields of soybeans.

Table 3. The Average Weight of 100 Beans and Yield

Perlakuan	100 seeds weight (g)	Yield (ton/ha)
Organic Fertilizer:		
Petroganic (20 ton/ha)	39.89b*)	3.85b*)
Without petrogenic	32.4a	1.58a
HSD 5%	5.61	1.04
Phonska Fertilizer:		
Control (Without NPK)	29.47a	2.44a
25% recommendation	38.33bc	2.87a
50% recommendation	42.75c	3.16a
75%recommendation	36.51b	2.46a
100% recommendation	33.66ab	2.63a
HSD 5%	5.39	1.23

Descriptions: *) The numbers that followed by the same letters in the same column is not different in real-time trial of HSD 5%

The data in Table 3 showed that the 50% phonska recommendation treatment has the average 100 seeds weight 42.75 g or 45% more than without phonska (control), and also shows the highest yield of 3.16 ton/ha or 29.63% higher in comparison to control. According to the description in Biosoy 1 variety (Kepmentan, 2018) the weight of 100 beans for this variety is approximately 21,74 grams with the average yields of 2.71 ton/ha. The increase of the 100 seeds weight and yield increasing along with the increase of the Phonska dose reaching the 50% dose recommendation. The fertilization in a high dose until a certain point will give effect on the increasing yield, and on a concentration beyond a certain point will decreased the yield (Kuruseng and Hamzah, 2011).

The use of inorganic fertilizer to the soybeans was done to supply the nutrients of nitrogen, phosphor, and potassium with a certain ratio. The absorption of inorganic fertilizer is faster than the organic fertilizer. It is possible that the organic fertilizer that has been added to the soil has not been unraveled perfectly. However, the use of inorganic fertilizer continuously can give effect on the damage of the field. Hayati *et al.* (2011) showed that organic fertilizer could repair the soil physical traits, especially the texture, water binding ability, but can only give enough nutrients to the plants. In contrast, the inorganic fertilizer could fulfill the needs of nutrients for plants but could not fix the physical traits of the soil.

The results of this experiment also showed that the application of 20 tons/ha of petroganic fertilizer for soybeans have a real increase in the weight of 100 seeds for 23.12 % and yields for 142.98% in comparison to control (without treatment). The soybeans yield with the treatment of organic for 20 tons/ha in equivalent to 3.85 tons/ha. This is the same with the research of Malau, *et al* (2015) which found that the increase of organic fertilizer as many as 750 kg/ha (0.75 tons/ha) could give a real effect for the increase of 100 beans weight in comparison to the control. Suarsana, *et al* (2018) and Mayani, *et al* (2021) stated that the increase of organic fertilization each for 8 ton/ha and 7.5 tons/ha could increase 100 seeds weight in comparison

to the control. Organic fertilizer according to Leiwakabessy, *et al* (2003) is used to repair the soil structure; increase the availability of N, P, and S substances; increase the cation exchange capacity (CEC); and activate the microorganism. Besides that, some researcher showed that organic fertilization and inorganic fertilization could increase the soil's pH rate, N-total, P-available and K-available in the soil, the rate of absorption of N, P, K nutrients, and increased the production rate of corns (Djuniwati *et al*., 2003) and also increased the production rate of soybeans.

This organic and inorganic fertilization is supported by the result of Puspadewi, *et al* (2016) research which stated that the combination of liquid organic fertilizer and N, P, K fertilizer could affect the growth and yield rate of sweet corns. With this, the application of organic and inorganic fertilizer with low dose recommendation is recommended cultivation technique, since it could decrease the pollution rate from too many inorganic fertilizers. And it could repair the soil's physical traits, chemical, and biology in dry lands.

CONCLUSION

There is no interaction between organic and inorganic fertilizer, but each of them could give significant effects to the weight of 100 beans, yield, and fresh and dry matter weight. Organic fertilization and phonska 50% recommendation fertilizer is the best treatment to increase the weight of 100 beans (42.5 g), yields (4.55 kg/plot) the same with 3.16 tons/ha, the fresh weight (83.30 kg/plot) and the dry matter weight (64.49 kg/plot), so that cultivation technology engineering that produces more than 2,71 tons/ha in dry lands could be reached.

ACKNOWLEDGEMENTS

Gratitudes are given to Dr. Lolita Endang Susilowati and Dr. Herman Suheri, who help the experiment in the field and Akhmad Zubaidi, Ph.D who help read the manuscript.

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