Utilization of hush ash on growth and yield of soybean (*glycine max* l.) No-tillage cultivation

Supriyono[2] , Jauhar Kumala Shuni[1], Maria Theresia Sri Budiastuti[3] , Sri Nyoto[4]

[1]*Undergraduate Agrotechnology Study Program, Faculty of Agriculture, UNS Surakarta*
[2,4]*Lecturer of Agrotechnology Study Program, Faculty of Agriculture, UNS Surakarta*

ABSTRACT

Soybean (Glycine max L.) is an annual plant that contains lots of protein and is rich in benefits. Soybean is one of the essential food crops after rice and corn. Soybean production has decreased from year to year due to reduced soybean planting land, substantial capital, and regulation of soybean prices in an unstable market. Cultivation technology needs to be developed through the availability of local resources and soil structure protection by utilizing husk ash as a source of organic material with no-tillage cultivation. The study was conducted in Pengkok Village, Sragen Regency in June-September 2019, in the form of a field trial using Completely Randomized Block Design (RCBD), one factor of husk ash dose with 5 levels and 5 replications so that 25 unit experiments were obtained. The observed variables were plant height, number of leaves, root shoot ratio, leaf area index, number of pods per plant, number of seed per pod, the weight of seeds per plant, the value of 100 seeds, and dry weight of a straw. The results showed that applying 2.5 tons/ha of husk ash can increase the leaf area index in the growth component. An increase in yield of seeds per plot due to husk ash 1.25 tons/ha. The application 1.25 tons/ha of husk ash is recommended to farmers to increase yield per hectare of soybeans in the amount of 0,73 ton/Ha.

Keywords: *LAI, husk ash, Seed Weight per plot*

INTRODUCTION

Soybean (*Glycine max* L.) is an annual plant that contains a lot of protein. Soybean is one of the essential food crops in Indonesia after rice and corn. Soybeans have various uses, especially as a raw material for the food industry rich in vegetable protein. Soybean is a vegetable protein source with 39% content, where 2% of all Indonesian people get a source of protein from soybeans [1].

Indonesian soybean productivity decreased by 3,95% in 2016 from 15,68 q/Ha to 14,90 q/Ha and decreased by 4,62% in 2018 from 15,14 q/Ha to 14,44 q/Ha. The decrease of soybean production could not suffice the needs of soybeans in Indonesia; the cause is the lack of land use or agricultural land intensification for soybeans. One of the efforts to cultivate soybeans on the former rice cultivation land with no-tillage cultivation is to cultivate soybeans. The activity is intended to optimize land use so that it is productive.

Efforts that can be made are implementing a conservation tillage system (CTS), an agricultural land utilization activity that considers long-term social and farming aspects. Conservation tillage is divided into two types, namely minimum tillage cultivation and no-tillage cultivation. No-tillage cultivation has several advantages, such as saving costs, accelerating planting, reducing labor, and preventing soil erosion so that nutrients in the soil are not easily lost [2].

The use of ash on untreated rice fields will help the soil provide nutrients that plants can utilize. Unplanned rice planted land contains several elements, such as N, P, K, and Mg. However, due to the soil's acidic nature, these elements cannot be utilized by plants because they are still absorbed in the soil. To free the elements, these elements are needed organic material that can release the absorbed elements. Husk ash plays a role in increasing the availability of P, K, Si, and Carbon nutrients in the soil [3]. This study aims to study the role of rice husk ash on soybean growth and yield.

MATERIAL AND METHOD

This research was conducted in June - September 2019 in Pengkok Village, Kedawung District, Sragen Regency, Ecology and Plant Production Management Laboratory, and Soil Chemical Laboratory, Faculty of Agriculture, Sebelas Maret University, Surakarta. The research location is located at -7 ◦28 '49 "and 110 ◦59' 51" with a height of 153.8 meters above sea level. This research was conducted at the end of the rainy season. The average air temperature ranged from 37-40 ◦C. Soil analysis was categorized based on the Soil Research Institute 2009. The analysis results showed a soil pH of 6.74 (neutral) with N and P content low, at 0.16% and 7.58 ppm. The K content of 0.23me% is classified as low. Organic C value of 1.14% (low) and C / N value of 7.12 (very low). This study used a Completed Randomized Block Design (RCBD) consisting of one factor with 5 levels and was repeated 5 times, so that 25 experimental plots were obtained. The factors used are the husk ash dose consisting of B0 (control / 0 tons / Ha), B1 (1.25 tons / Ha), B2 (2.5 tons / Ha), B3 (3.75 tons / Ha), and B4 (5 tons / ha). The size of the trial plot is 1,2 m x 1,8 m. Variables observed were plant height,

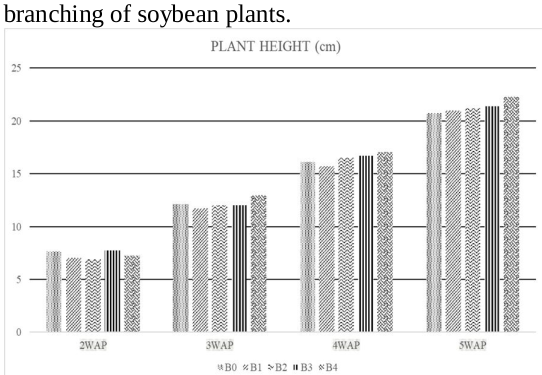
number of leaves, root shoot ratio, LAI, number of pods per plant, number of seeds per pod, the weight of seeds per
plant, the weight of seeds per plot, the weight of 100 seeds
and dry weight of a straw.

RESULT AND DISCUSSION

Growth Variable

Plant height

Observation of plant height in this study was carried out when soybeans were 2 WAP (Weeks After Planting). Observations are carried out once a week for 1 month. Plant height measurements were carried out, starting from the ground level to the last branching of soybean plants.



Picture 1. Plant Height (cm) Soybean (*Glycine max* L.) in the Dose Ash Husk Treatment

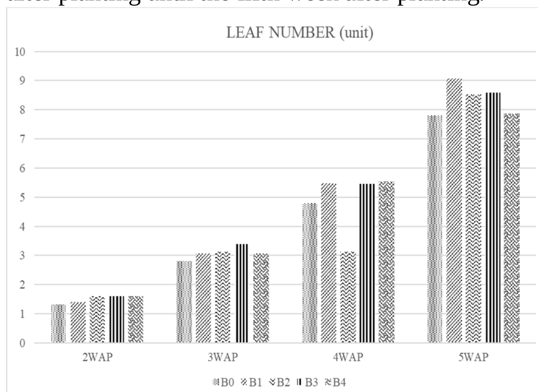
Note: B0: Without husk ash (0 tons/ha)
B1: Application 1.25 tons/ha of husk ash
B2: Application 2.5 tons/ha of husk ash
B3: Application 3.75 tons/ha of hush ash
B4: Application 5 tons/ha of husk ash

The observations found in observations in the second week, the highest plant height in the B3 treatment (3.75 tons/ha of ash husk dose). In the third week to the fifth week, the best plant height was treated B4 (5 tons/ha of ash). This is consistent with Aminudin and Chabib[4] statement that the addition of plant height during the vegetative phase occurs in the third and fourth weeks due to the plant's response to absorbing high nutrients. Prasetyoko [5] states that the husk ash that is used can affect plants' vegetative growth, the higher the dose of husk ash that is given can provide the best plant height results in soybean plants.

High potassium content in husk ash can affect soybean plant height. Potassium plays a role in increasing plant resistance to plant-disturbing organisms and can stimulate soybean roots' growth. This statement is reinforced by Rukmi [6]; potassium can increase plants' resistance from certain deceases, improve the root system, inhibit the effects of lodging, and prevent too much nitrogen poisoning. Another opinion expressed by Siregar et al. [7] that husk ash can improve soil physical and biological properties and has a high Cation Exchange Capacity *(*CEC) to stimulate the growth of soybean plants.

Number of Leaves

The leaves are one part of the plant that has an essential function in food processing in photosynthesis. Observation of the number of leaves is done by counting the leaves in one sample plant. Observations were made starting on the second week after planting until the fifth week after planting.



Picture 2. Number of Leaves (units) Soybean (*Glycine max* L.) in the Dose Ash Husk Treatment

The results showed that the best number of leaves in this study was B2 (1.25 tons/Ha of husk ash dose), except at the age of 3 weeks after planting. These results indicate that the higher quantity of husk ash given does not affect the number of soybean leaves. According to Johnston and Bruulsema [8], fertilization must pay attention to the right dosage, type, and time of application to more efficient, so that it can give benefit to economically, socially, and environmentally. The leaves function is to catch the light and carry out photosynthesis to produce photosynthates, used as food as plant energy. According to Buntoro et al. [9], the more leaves, the more light is captured to improve the photosynthesis process and affect plant growth.

Many small amounts of leaves of a plant are also determined by environmental conditions and nutrient content found in the soil. This research uses husk ash, which has a high nutrient K content. Potassium is needed in the vegetative phase of plants. According to Haryadi et al. [10], potassium regulates stomata's movement, increasing the number of soybean leaves. This statement is supported by Gardner et al. [11] that potassium is an essential activator of enzymes in photosynthesis and respiration to regulate and maintain osmotic pressure and water uptake, which will have a positive influence on the opening and closing of stomata.

Table 1. Mean of Soybean Growth Components in Various Doses of Rice Husk Ash Doses

Ash Husk Dosage	Root Root Ratio	Leaf Area Index
B0	0.21a	0.28a
B1	0.18a	0.25a
B2	0.20a	0.49b
B3	0.18a	0.32ab
B4	0.23a	0.22a

Note: Numbers followed by unsame letters indicate significant differences in DMRT testing at 5%

Root Shoot Ratio.

The highest root shoot ratio was B4 treatment (5ton/ha of husk ash dose) of 0.23 gram and was not significantly different from other doses, namely B0, B1, B2, and B3. The lowest root shoot ratio in treatment B1 (1.25 tons/ha of husk ash dose) was 0.18 grams. The root shoot ratio in this study is relatively low because, according to Efendi[12], the ideal value for the crown root ratio is 5.7 to 7.3. This is because the proportion of roots is smaller than the balance of the shoot. This statement is in accordance with Rahmawati et al. [13] that the value of root shoot ratio of plants is useful if the proportion of roots is higher than the proportion of shoot because profitable root growth will affect plant growth so that the absorption of nutrients is more optimal in meeting the nutritional needs of plants and has profitable growth and production. The high or low value of plants' root shoot ratios is influenced by food reserves and nutrient sufficiency, another opinion expressed by Bolinder et al. [14] that the ratio of root shoot is influenced by location and climatic conditions. Low carbon content can affect plant growth if given in large quantities and need to observe to the dose so that its use is not excessive. This is in accordance with Rahmatika et al. [15], which states that carbon content, which is not too high if added to the soil, is quite a lot and given continuously, can increase the concentration of C, P, S, and N in the ground. Hidayat et al. [16] added that organic matter to the soil could increase the roots and shoot of plants.

Root and shoot ratios have different values because they are influenced by different soil types and other climatic conditions during harvest. According to Sainju et al. [17], root shoot ratio at harvest is used to estimate root biomass and carbon effects from residues in the soil. The value of the root shoot ratio of plants shows the amount of photosynthesis accumulated in plant organs.

Leaf Area Index.

The highest leaf area index value in treatment B2 (2.5 tons / Ha of the husk as dose) was 0.49 and significantly different from treatment B0, B1, and B4. The lowest leaf area index value in treatment B4 (5 tons / Ha of husk ash dose) was 0.22 and significantly different from treatment B2 (Table 4). This means that the leaf area index is affected by the right dose of husk ash and is not be affected by the higher dose of husk ash. According to Hidayat [18], the right dose is according to the plant's needs, not excessive, and not less. Firmansyah et al. [19] added that the use of the right dose could affect both the growth and yield of plants. The use of doses that are too high can harm plants because they can be toxic, not good for the environment, and require high costs.

Measurement of leaf area index value is affected by planting distance and leaf area. According to Susanti et al. [20], a small leaf area index value indicates that there is still sunlight that can penetrate the soil without being blocked by the leaves, and the light cannot be utilized by the leaves for photosynthesis. Pangaribuan et al. [21] state that the higher leaf area means that the process of photosynthesis is higher so that more photosynthates are produced.

Yield Variable

Table 2. Mean of Soybean Yield Components in Various Treatment of Ash Husk Ash Doses

Ash dose	Number of Pods per Plant	Number of Seeds per Pod	Seed Weight per Plant (gram)	Seed Weight per Plot (gram)	Weight of 100 Seeds (gram)	Dry Stover Weight (gram)
B0	31,67 a	2,31a	10,67a	78,39a	14,16a	15.04 a
B1	34,27 a	2.27a	11.66a	175.01 b	14.05a	15,37a
B2	33,00 a	2,18a	10,68a	120.27 ab	13,19a	16.42a
B3	34,67 a	2,20a	11,69a	150,59 ab	14,16a	18,19a
B4	26,33 a	2.26a	8,87a	120.09 ab	13,77a	12,51a

Note: numbers followed by unsame letters indicate significant differences in DMRT testing at 5%

Number of Pods per Plant.

Table 2. shows the results of the highest number of pods in B3 treatment (3.75 tons/ha of husk ash dose). The lowest number of pods was in the B4 treatment (5 tons/ha of husk ash dose). Giving various doses of husk ash does not show any significant difference between the dose of husk ash to the number of soybean pods. Jumrawati [22] states that the number of pods in soybeans is affected by vegetative growth, such as photosynthesis rate and assimilation results. Low soil nutrient conditions and the addition of husk ash are still not enough to meet the needs of soybean, so the application of various doses of husk ash does not affect the number of soybean pods.

The formation of pods in soybean plants is affected by nutrient nitrogen (N). Permanasari et al. [23] added that nitrogen functions to arrange proteins and chlorophyll, which are useful in photosynthesis, and the results of this photosynthesis would be used by plants for generative growth processes, including the formation of plant pods. During the research, the soil contained low nitrogen (0.16%), while nitrogen in the husk ash was also low and volatile. This is in accordance with research conducted by Rahmatika et al. [15], which states that the nitrogen content in husk ash is 0.16% (low).

Number of Seeds per Pod.

The highest number of seeds per pod in treatment B0 (control) was 2.31 and was not significantly different from treatment B1, B2, B3, and B4, which was 2.27; 2.18; 2.20; 2.26. In general, the highest number of seeds per pod in this study consisted of 2 soybeans in each pod and the least soybean pod containing one seed. Pandiangan and Rasyad[24] state that the ability of plants in seed formation in pods is determined by adequate nutrients in plants. The potassium content contained in the husk ash can function in the generative phase to produce pods and seeds. This is in accordance with the opinion of Asbur[25}, which states that the potassium content in ash husk can stimulate seed formation.

The various doses given in this study did not affect the number of seeds per soybean pod. This can be caused by various things, one of which is the dose of husk ash, which is too low. According to Efendi [26], low doses of husk ash cannot have an obvious effect on plants. The small number of seeds per pod is affected by the number of pods. The more number of pods, the greater number of seeds in each pod. This observation is supported by Dwiputra et al. [27], which states that the number of seeds has a close relationship with the number of pods. The higher plant height variable, the number of branches, the number of pods, and the number of wet rice will be followed by increasing in the number of soybean seeds. Syafira et al. [28] added that high soybean production could be seen from the number of seeds per pod. The more pods per plant, the soybean production will also increase.

Seed Weight per Plant.

Based on observations, it is known that there is no significant difference between the dose of husk ash and seed weight per plant (Table 2.). The amount of seed weight is determined by the number of pods and the number of seeds. Dwiputra et al. [27] state that the weight of seeds per plant is greatly affected by the number of seeds per soybean plant. Kamil[29] adds that the high and low weight of the seeds depends on how much dry matter is contained in the seeds, the shape, and the size of the seeds that are affected by plant genes. The highest seed weight value in the B3 treatment (3.75 tons/ha of husk ash dose) was 11.68 grams and was not significantly different from other doses. The application of the husk ash dose to 5 tons / Ha caused the weight of the seeds per soybean plant decrease to 8.87 grams, while the reduction of the dose to 2.5 tons / Ha, 1.25 tons/ha, and the control gave results that were not too far away with the treatment 3.75 tons/ha.

The prominent nutrient content in the husk ash beside the K element and carbon is Si (Silicate). This is consistent with the results of the analysis of Rahmatika[13], which shows that the Si content is 26.27 with moderate value. The application of husk ash can affect the weight of seeds per plant. This is because the husk ash contains the Si element, which has the same function as K, which makes the plant stronger, so it does not easily fall. Syafira et al. [27] added that silicates could increase soybean production due to improved photosynthesis because leaves coated with silicates are more upright and not easily drooped. Upright leaves allow penetration and distribution of light more evenly so that the process of photosynthesis can run optimally. The process of photosynthesis during the generative phase that runs optimally can increase photosynthate, which will be utilized in filling pods and seeds so that the seeds can be filled optimally and have a high weight.

Seed Weight per Plot

The results showed that the application of husk ash could increase the weight of seeds per plot (Table 2) because the treatment of husk ash has a higher weight compared to the control treatment (0 tons/ha). The highest seed weight per plot in treatment B1 (1.25 tons / Ha of husk ash dose). The control treatment was significantly different from the B1 treatment (1.25 tons/ha husk ash dose) and was not significantly different from the B2, B3, and B4 treatments. The results showed that the application of husk ash could increase the weight value of seeds per plot. This can be seen from Table 8., which shows the weight value of control treatment seeds is only 78.39 grams, while the treatment values of B1, B2, B3, and B4 are 175.01 grams, 120.27 grams, 150.59 grams, and 120.09 grams. Increasing the weight value of seeds per plot can be caused by the potassium content found in the husk ash. This statement is supported by Hussain et al. [30] that potassium given to infertile soils can improve yield components and crop quality.

The results of this study are relatively low. The low yield of soybeans is due to the disruption of rat pests and pod borer. In addition, low soybean yields are also caused by low doses. Another opinion expressed by Suranto et al. [31] that the use of husk ash in plants needs to be balanced with the provision of inorganic fertilizers such as NPK so that nutrient needs in the soil can meet the needs of plants. Plant growth and development during the vegetative phase is good because plants' growth elements can be fulfilled so that the development during the generative phase is also good. Zainal et al. [32] added that an increase in soybean yield was related to the number of plant leaves because an increase in the number of leaves would lead to higher light capture so as to increase the photosynthesis process and the potential for the assimilate to be transplanted to the seeds would increase.

Weight of 100 Seeds

Results in Table 2. showed the highest weight of 100 seeds in the control and B3 treatments (3.75 tons/ha of husk ash dose) and was not significantly different from other husk ash doses, namely B1, B2, and B4. The weight of 100 seeds of control and B3 treatment has the same value, which is 14.16 grams. The high and low weight of 100 seeds, according to Pandiangan and Rasyad[23], is determined by the ability of plants to translate assimilates into seeds to produce seeds.

The weight of 100 seeds is one component of the yield associated with the quality of seeds produced by plants. According to Hastuti et al. [33], the weight of 100 seeds is affected by the availability of nutrients and the ability of plants to absorb these nutrients. One of the important nutrients in the seed filling phase is phosphorus (P). Lambers et al. [34] state that phosphorus is a constituent component of compounds for energy transfer (ATP / other nucleoproteins) to DNA and RNA and then passed on to cell membranes (phospholipids) and phosphoproteins.

The weight yield of 100 seeds in this study tends to below, this is due to several things, namely the presence of pest disorders during the generative phase and the lack of nutrients that can stimulate seed filling, such as phosphorus and potassium. The availability of phosphorus in the low-value research soil, which is 7.58ppm, is classified as very low (Table 1.), while the phosphorus contained in the husk ash cannot fulfill plant needs. Based on research by Bakri[35], the content of phosphorus (P) in husk ash is 0.2 %. Nutrients that have not been able to fulfill the needs of these plants need to be improved so that plants get an optimal nutrient intake in accordance with their needs. The statement is in accordance with Sarwa et al. [36] that the optimization of plant growth and production will be achieved if nutrients are optimally available for plants.

Dry Weight of Straw

Based on the results of the study, it can be seen that all treatments of husk ash dose were not significantly different (Table 2.). The highest dry weight of straw was in B3 treatment (dose of husk ash, 3, 75 tons / Ha). Each treatment had a difference in dry strawweight that was not too far apart, except for the B4 treatment (5 tons/ha of ash dose). In a row, the dry weight of the straw of B0, B1, B2, and B3 treatments increased, but there was a decrease in the application of husk ash dose of B4 treatment. This can show that the addition of husk ash to 5 tons/ha has no effect on the high dry weight of soybean str. The dry weight of straw is affected by the growth rate. This is supported by the statement of Suranto et al. [31], which explains that the higher the growth rate of plant organs such as stems and leaves, the dry weight produced will also be higher.

High and low dry strawweight is also affected by the amount of nutrient uptake during the process of plant growth and is affected by the process of photosynthesis. One of the nutrients that affect the dry weight of stover is phosphorus. This is supported by the statement of Mehdi et al. [37] that phosphorus affects the process of energy transfer and storage, cell division, and carbohydrate metabolism, thus helping in increasing the dry weight of a straw. Syafira[28] states that the dry weight of straw is the result of the effectiveness of nutrient absorption and reflects the ability of plants to produce photosynthates by binding to solar energy through photosynthesis. Dry weight also indicates the interaction of plants with their environment.

CONCLUSIONS

Conclusion

Based on the results of research and discussion, conclusions can be obtained as follows:

1. Soybeans fed with 2.5 ton/ha husk ash have better leaf area index growth compared to controls.
2. Application 1.25 tons / Ha of husk ash increase the yield in the form of seed weight per plot in the amount of 122,94% becomes 0,729 tons/Ha compared to without husk ash or control.

Suggestion

Based on research on increasing soybean growth and yield through the use of husk ash, it can be suggested that the administration of husk ash at a dose of 1.25 t / ha can be recommended to be applied at the level of soybean farmers no-tillage cultivation.

Acknowledgments

Thanks are conveyed to the UNS PNBP team for allocating funds so that this research can be carried out.

References

[1] A Sadam, A Barus, Mariati. 2018. "*Karakter morfologi kedelai (Glycine max (L.) Merril) tercekam kekeringan melalui aplikasi antioksidan*". J Pertanian Tropik 5(1): 94-103.

[2] A Kusumastuti, A Wijaya, Y Sukmawan. 2018. "*Effect of no-tillage soil system and N residue year 29th on chemical soil leguminosae plant indicator*". Journal of Applied Agricultural Sciences 2(1): 20-29

[3] FN Sukmawati, Z Zein. 2016. "*Pemnafaatan abu dapur sebagai media tanam pembibitan kakao* (*Theobroma cacao*)". Gontor AGROTECH Science Journal 2(2): 1-16

[4] M Aminuddin, M I S Chabib. 2005. "*Pengaruh dosis larutan nutrisi terhadap hasil beberapa varietas kedelai. Agritop*", Jurnal ilmu-ilmu Pertanian.

[5] D Prasetyoko, Laksono, A Putro. 2007. " *Jurnal : abu sekam sumber silika pada sintesis zeolit zsm-5 tanpa menggunakan templat organik*". Surabaya: Akta Kimia Indonesia.

[6] Rukmi. 2010. "*Pengaruh pemupukan kalium dan fosfat terhadap pertumbuhan dan hasil kedelai. Skripsi"*. Universitas Muria. Kudus. 68 hlm

[7] DA Siregar, RR Llahay, N Rahmawati. 2017. "*Respon pertumbuhan dan produksi kedelai (Glycine max (L. Merril) terhadap pemberian biochar sekam dan pupuk*" P. J Agroteknologi FP USU 5(3): 722-728

[8] A M Johnston and T W Bruulsema. 2014. "*Nutrient Stewardship for Improved Nutrient Use Efficiency*". Procedia Engineering 83 (365): 370

[9] B H Buntoro, R Rogomulyo, S Trisnowati. 2014. "*Pengaruh takaran pupuk kandang dan intensitas cahaya terhadap pertumbuhan dan hasil temu putih*" (*Curcuma zedoaria* L.). J Vegetalika 3(4): 29-39

[10] D Haryadi, H Yetti, S Yoseva. 2015. "*Pengaruh pemberian beberapa jenis pupuk terhadap pertumbuhan dan produksi tanaman kalian* (*Brassica alboglabra* L.)." JOM Faperta 2(2): 1-10.

[11] F.P Gardner, ,.R.B. Pearce dan R.L. Mitchel. 1991. "*Fisiologi tanaman budidaya*". Jakarta: Universitas Indonesia Press.

[12] Efendi. 2010. "Peningkatan pertumbuhan dan produkski kedelai melalui kombinasi pupuk organic lamtorogung dengan pupuk kandang. J Floratek 5: 65-73

[13] V Rahmawati, Sumarsono, W Slamet. 2013. Nisbah daun batang, nisbah tajuk akar, dan kadar serat kasar alfalfa (*Medicago sativa*) pada pemupukan nitrogen dan tinggi defoliasi berbeda. Animal Agriculture Journal 2(1): 1-8.

[14] M A Bolinder, D A Angers, D Belanger et al. 2002. *Root bbiomass and shoot root ratios of perennial forage crops in eastern Canada*. J Plant Sci 82: 731-737

[15] Rahmatika, S T Wulan, Z Arifin. 2018. Kajian dosis pupuk abu mineral sekam terhadap pertumbuhan padi dan serapan Si. J Crop Agro: 1-14.

[16] T C G Hidayat, L Simangunsong, Eka, et al. 2007. Pemanfaatan berbagai limbah pertanian untuk pembenah media tanam bibit kelapa sawit. Jurnal Penelitian Kelapa Sawit 15 (2) : 185-193.

[17] U M Sainju, B L Allen, A W Lenssen, et al. 2017. "*Root biomass, root/shoot ratio, and soil water content under perennial grasses with different nitrogen rates*". Field Crops Research 210: 183-191.

[18] W Hidayat. 2012. Manajemen pemupukan pada perkebunan kelapa sawit (*Elaeis guineensis* Jacq.) di Tambusai Estate, PT. Panca Surya Agrindo, First Resources Ltd., Kabupaten Rokan Hulu, Riau. Bogor. Skripsi. Institut Pertanian Bogor.

[19] I Firmansyah, M Syakir, L Lukman. 2017. Pengaruh kombinasi dosis pupuk N, P, dan K terhadp pertumbuhan dan hasil tanaman terung (*Solanum melongena* L.). J Hort 27(1): 69-78

[20] R A Susanti, T Sumarni, E Widaryanto. 2013. Pengaruh bahan organic terhadp pertumbuhan dan hasil tanaman padi (*Oryza sativa*) varietas inpari 13 sistem tanam jajar legowo. J Produksi Tanaman 1(5): 459-463

[21] D H Pangaribuan, K Hendarto, K Prihatini. 2017. Pengaruh pemberian kombinasi pupuk anorganik tunggal dan pupuk hayati terhadap pertumbuhan dan produksi tanaman jagung (*Zea mays saccharata* Sturt) serta populasi mikroba tanah. J Floratek 12(1): 1-9

[22] Jumrawati. 2010. Efektifitas Inokulasi *Rhizobium* sp. terhadap pertumbuhan dan hasil tanaman kedelai pada tanah jenuh air. Dinas Pertanian Provinsi Sulawesi Tengah.

[23] I Permanasari, M Irfan, Abizar. 2014. Pertumbuhan dan hasil kedelai (*Glycine max* (L.) Merill) dengan pemberiab rhizobium dan pupuk urea pada media gambut. J Agroteknologi 5(1): 29-34

[24] D N Pandiangan, A Rasyad. 2017. Komponen hasil dan mutu biji beberapa varietas tanaman kedelai (*iGlycine max* (L.) Merril) yang ditanam pada empat waktu aplikasi pupuk nitrogen. JOM Faperta 4(2): 1-14

[25] Y Asbur. 2020. Effect of the administration of rice husk ash and NPK phonska fertilizer on the growth and production of mung bean plants (*Phaseolus radiates*). World Journal of Pharmaceutical and Life Sciences 6(3): 158-169.

[26] Efendi. 1986. Bercocok tanam jagung. Jakarta: Yasaguna.

[27] A H Dwiputra, D Indradewa, E T Susila. 2015. Hubungan komponen hasil dan hasil tiga belas kultivar kedelai (*Glycine max* (L.) Merr.). J vegetalika 4(3): 14-28

[28] A Syafira, M S Poerwoko, Sundahri. 2015. Respon pertumbuhan dan produksi kedelai terhadap dosis pupuk kalium dan konsentrasi ekstrak abu sekam berpelarut asap cair. Berkala Ilmiah Pertanian 10(10): 1-4

[29] Kamil. 1996. Teknologi benih. Bandung: Angkasa Raya.

[30] An M Hussain, Arsyad, Z Ahmad, et al. 2015. Potassium fertilization influences growth, physiology, and nutrients uptake of maize (*Zea mays* L.). Cercetary Agronomice in Moldova. 48(1): 37-50.

[31] H Suranto, J Sjofjan, S Yoseva. 2015. Pemberian abu sekam dengan pupuk NPK terhadap pertumbuhan dan produksi tanaman jagung manis (*Zea mays saccharata* Sturt) pada tanah gambut. JOM Faperta 2(1): 1-15

[32] M Zainal, A Nugroho, N E Suminarti. 2014. Respon pertumbuhan dan hasil tanaman kedelai (*Glycine max* (L.) Merill) pada berbagai tingkat pemupukan N dan pupuk kandang ayam. J Produksi Tanaman 2(6): 484-490.

[33] D P Hastuti, Supriyono, S Hartati. 2018. Pertumbuhan dan hasil kacang hijau (*Vigna radiate* L.) pad beberapa dosis pupuk organik dan kerapatan tanam. Caraka Tani: Journal of Sustainable Agriculture 33(2): 89-95

[34] H Lambers, F S Chapin, T L Pons. 2008. Plant physiological ecology. New York, NY: Springer New York

[35] Bakri. 2008. Komponen kimia dan fisik abu sekam sebagai SCM untuk pembuatan komposit semen. Journal Perennial, 5: 9-14

[36] Sarwa, A Nurmas, M Dasril. 2012. Pertumbuhan dan produksi tanaman kedelai (*Glycine max* L.) yang diberi pupuk guano dan mulsa alang-alang. J Agroteknos 2(2): 97-105

[37] S M Mehdi, Obaid-ur-Rehman, M Sarfraz, et al. 2010. Residual effect of wheat applied phosphorus on sorghum fodder in a sandy loam soil. Pakistan Journal of Science 62(4): 202 – 206.

[38] Supriyono, Made Edo Lisando, Trijono Djoko Sulistyo, Sri Nyoto, *"Role of Biofertilizers and Organic Fertilizers on Growth and Yields of Soybean"* SSRG International Journal of Agriculture & Environmental Science 6.6 (2019):32-36