IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 16, Issue 8 Ser. I (August. 2023), PP 55-62
www.iosrjournals.org

Correlation Of Morpho Agronomic And Nutrient Uptake Of Rice (Oryza Sativa L.) After Application Of Soil Amendments In Newly Paddy Fields

Irwan[1], Muyassir[1], Helmi[1]
[1](*Magister of Agroecotechnology Study Program, Agriculture Faculty of Syiah Kuala University, Jalan Tgk. Hasan Krueng Kalee, Darussalam-Banda Aceh Indonesia*)

Abstract: *Newly cleared land is dominated by low soil fertility problems. It is necessary to provide soil amendments to increase soil fertility and yield potential in new cleared land. The study was conducted with a factorial randomized block design with 3 replications. Soil amendments with three levels of biochar and manure 20 t ha^{-1} and no amendments, while the rice lines tested were 6 lines. The results showed positive and negative correlations between morpho agronomic parameters and nutrient uptake of rice in newly cleared land after being given soil amendments. K uptake in rice is closely related to yield potential and plant height. Grain weight is closely related to the harvest index. Knowing the correlation between parameters can be a reference in determining appropriate agronomic technique to increase rice production in newly rice field.*

Keywords *: root shoot ratio, grains, biochar, manure*

Date of Submission: 18-08-2023 Date of Acceptance: 28-08-2023

I. Introduction

The increase in world population must be matched by an increase in food production. In 2050 it is estimated to reach 8.9 M people [1]. World food must increase by 60%. Newly paddy fields continues to be carried out to increase food production. Rice planting in newly opened land, Inhibited by low soil fertility. This is because in general the newly opened land has a low organic matter content, so that it has not been able to hold organic matter optimally. [2] newly opened rice fields have several problems such as low nutrient uptake, organic matter, water shortages, inappropriate fertilization management and poor farmer skills.

Increasing soil fertility in newly cleared land for food cultivation is carried out by applying organic soil amendments such as green manure, guano, biochar and manure. The last two soil amendments are easier to obtain and are available in abundant quantities, so they can be used as soil amendments without causing problems with their availability in a sustainable agriculture. Compost is organic material (organic waste) that has undergone a weathering process due to interactions between microorganisms (decomposing bacteria) working in it. Compost can increase the availability of nutrients in the soil, especially nutrients that are soluble in weak acids or because of the nature of the chelating properties. In addition to compost, adding microbes to the planting medium can increase physical and chemical biological fertility [3].

Biochar as a soil amendment has properties to improve soil porosity, soil health, soil specific gravity and cation exchange capacity. Meanwhile, manure as a soil amendment besides being able to improve chemical fertility, can also improve soil biological fertility. Several studies have shown the advantages and disadvantages of biochar and manure as soil amendments. Biochar is an activated carbon that can improve soil porosity, water availability, and nutrient availability. Biochar has a larger surface area so it can reduce the specific gravity of the soil [4]. Biochar not only increases soil water content but also absorbs excess Na^+ thereby increasing plant nutrient status [5]. Biochar can be made from raw materials, in the form of agricultural waste such as rice husks, coconut shells, cocoa shells and so on [6]. The organic components of biochar have a high carbon content and the inorganic components contain minerals, such as Ca, Mg, K, and inorganic carbonates (carbonate ions), depending on the type of raw material [7].

Soil that has biochar residues is a good planting medium because biochar has pores that can store nutrients available when plants need them [8]. Based on the research results of [9] application of biochar resulted in the highest efficiency of plant water use, 0.77 g mm-1 compared to without the addition of biochar which was only capable of water efficiency of 0.43 g/mm. [10] states that water available in the soil is more available with the application of biochar, so as to increase the efficiency of water use by plants. Biochar can increase soil fertility. Biochar is an activated carbon that can improve soil porosity, water availability, and nutrient availability. The addition of biochar is used because it can improve the physical, chemical and biological properties of the soil [11]. Biochar can be used as a soil enhancer for soil fertility [12].

The role of manure and biochar in improving soil fertility has been widely studied. Manure 15-20 t ha-1 can minimize 15% of inorganic fertilizer [13]. Manure can increase crop yields during the 10 WAP drought period [14]. Soil amendments can increase NPK uptake [15]. Rice yields are affected by manure and the effects of inorganic fertilizers [16]. Efficiency of K uptake by manure doses [17]. Manure residues affect soil N [18]. Other soil amendments such as biochar can affect soil fertility by changing physical and chemical properties and increasing soil function and crop yields [19]. Giving 20 t ha-1 of biochar can increase plant height, number of panicles and dry weight of rice straw in clumps [19]. Goat manure and varieties have an effect on the agronomic character of rice [20]. It is important to know the changes in agronomic morpho parameters and nutrient uptake of rice, after applying soil amendments to several lines studied to be a reference in determining the appropriate agronomic technique, according to the correlation between parameters for newly opened paddy fields.

II. Methodology

The research was conducted in Bueng Tujoh (5o.50'5'14"N 95o47'67'36" E), Atong village, Montasik sub-district, Aceh Besar district on community paddy fields opened in 2019. The research was carried out during the planting season from August to December 2021.

Tools and materials: The materials used were 6 rice lines namely: (1) Inpari 42, (2) C3, (3) TG IRBB 27, (4) 15 E 1009, (5) F1 (C4 x KH), and (6) (Sigupai) F2; NPK fertilizer, SP36 urea fertilizer, and KCl as well as materials for NPK absorption analysis. While the tools used are soil processing machines (tractors), tape measure, seed counter, label boards, label paper, labeled bags, spectrophotometers, and NPK uptake with wet ashing method.

Study design : This study used a 3x6 factorial randomized block design with 3 replications. There were 18 treatment combinations with 54 experimental plots. The main factors are three levels of soil amendment consisting of A_0 without soil amendments, A_1 using biochar (20 t ha^{-1} or 4.8 kg $plot^{-1}$), and A_2 using manure (20 t ha^{-1} or 4 ,8 kg $plot^{-1}$). The second factor was the rice lines which consisted of 6 lines: L_1 (Inpari 42), L_2 (C3), L_3 (TG IRBB 27), L_4 (15 E 1009), L_5 (F1 C4 x KH) , and L_6 (Sigupai).

Research Implementation

Seed nursery

Seeds from 6 rice lines were soaked in water for 24 hours then drained and incubated in the seeds in the germinator for 2x24 hours. After the seed shown the roots, they are down in the nursery. Nursery beds are made a week before sowing the seeds. Using a 1.5x5 meter nursery bed. After sowing the seeds, urea, SP36, and KCl fertilization were also carried out, 5 grams per square meter each. The beds are kept in a state of water saturation until they are 3 weeks old.

Pull out of rice seedlings

Rice seeds are pulled out at the age of 3 weeks after sowing (WAS). The seedlings were pulled out when the nursery bed was flooded.

Planting plots

Planting plots were prepared a month before planting together with making a nursery. The beds are made measuring 1.2 x 2 meters with 54 plots. The beds are turned over the soil 2 times, the first time with a short plow, the second with a rotary plow, and left for 2 weeks. The beds that have been turned over 2 times are immediately given 4.8 kg $plot^{-1}$ or 20 t ha^{-1} . Of soil amendment $plot^{-1}$ by sowing evenly on the surface and then turning the soil over until the soil conditioner is evenly distributed over the plot to a depth of 20 cm. At the time of planting, the rice fields were flooded with water and harrowed until they became muddy. Planting is done with a spacing of 20 x 20 cm.

Planting rice lines

Line sowing was carried out in experimental beds by planting 3 weeks old lines. Spacing of 20 x 20 cm, there are 60 plant $plots^{-1}$ measuring 100 cm x 120 cm.

Maintenance

Maintenance is carried out by fertilizing, controlling pests and diseases, weeds, and managing water according to the growth phase of the rice plant. Fertilization is done at the age of 0.30 and 45 HST by providing basic fertilizer. Basic fertilizer in the form of NPK 900 kg ha^{-1} at planting and 150 kg urea per hectare at planting plus SP 36 200 kg ha^{-1} and KCl 100 ha^{-1} . Follow-up fertilization 1 and 2 in the form of Urea 150 kg ha^{-1} at the age of 30 and 45 HST. Maintenance is carried out by keeping the condition of the water in the land to meet the needs of the rice plant. Weed control is done manually. Disease control is carried out using pesticides.

Parameters

Plant height (cm)

Plant height was observed at 6 WAP and harvest [21].

A number of leaves

The number of leaves was observed at the age of 6 MST and harvest [21].

A number of tillers

The number of tillers was observed at the age of 6 MST and harvested by counting the number of tillers emerging from the main stem [21].

Biomass fresh weight (g)

Biomass fresh weight was observed by weighing all parts of the plant in each sample plant at harvest which had been cleaned of any adhering soil [21].

Biomass dry weight (g)

Dry weight was observed by weighing all parts of the plant used in each sample in a dry state which had been sun-dried for 14 days in a greenhouse [21].

Root dry weight (g)

The dry weight of the roots was observed by weighing them after obtaining a constant moisture content, namely after the roots were dried by drying them in a greenhouse for 14 days [21].

Shoot dry weight (g)

Shoot dry weight was carried out by drying in a greenhouse for 14 days then after being constant weight. it was weighed with a digital scale and expressed in g $hill^{-1}$ [22].

Root shoot ratio

The root shoot ratio was obtained by comparing the root dry weight and shoot dry weight [22].

Weight filled grain (g)

The weight of the filled grain, 13% water contains after oven for 3x24 at for 40 ^{0}C. The weight is determined by weighing the filled grain with an analytical balance [21].

1000 grain weight

The weight of 1000 grains is calculated by weighing 100 grains then dividing by 100 and the result is multiplied by 1000 (Hanafi et al., 2018)

Productivity (t ha^{-1})

The productivity of t ha^{-1} was observed by converting the weight of filled grain at meter square of net plot than multiplied by 10000 [21].

Harvest index

Determined by grain weight hill $^{-1}$ divided by shoot weight [21].

Nutrient uptake of N, P, and K in the shoot

NPK nutrient uptake was carried out on a dry shoot using a wet ashing method using sulfuric acid and hydrogen peroxide extraction. The analysis was carried out at BPPT Aceh Province. Absorption is calculated in %.

Data analysis

The data obtained were analyzed using ANOVA (Analysis of Variance). then proceed with the pearson correlation using SPSS version 26.

III. Result And Discution

The correlation between rice morpho agronomic parameters due to the application of soil amendments and 6 rice lines can be seen in table 1 below.

Table 1. Relationship between rice morpho agronomic and nutrients uptake parameters due to application of soil amendments of 6 rice lines

Correlations Parameters																		
	X1	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	**X11**	**X12**	**X13**	**X14**	**X15**	**X16**	**X17**	**X18**
X1	1	-.649**	-.505*	-0.065	-0.227	-0.191	-0.007	-0.246	-0.358	-0.178	-0.433	0.396	.968**	.523*	1,000**	0.084	-0.104	.587*
X2		1	0.443	-0.044	0.282	0.310	-0.237	0.172	0.138	-0.044	0.281	-0.303	-.521*	-0.401	-.649**	0.147	0.186	-0.274
X3			1	-0.169	-0.010	0.322	-0.233	0.077	-0.006	0.428	0.100	-0.334	-0.467	-0.451	-.505*	0.051	-0.422	-0.460
X4				1	-0.128	-0.126	0.064	0.117	0.153	0.368	-0.123	-0.255	-0.041	-0.368	-0.065	0.255	-0.067	-0.330
X5					1	0.121	0.270	.862**	0.337	-0.011	0.377	0.149	-0.203	0.101	-0.227	-0.033	0.393	-0.009
X6						1	-0.066	0.234	0.115	0.161	0.337	-0.278	-0.164	-0.343	-0.191	0.423	-0.326	-0.243
X7							1	0.320	-0.053	0.019	-0.053	-0.072	-0.066	0.019	-0.007	0.244	0.365	0.080
X8								1	0.403	0.034	0.466	0.047	-0.245	-0.024	-0.246	0.125	0.151	-0.255
X9									1	0.165	.874**	-0.273	-0.393	-0.373	-0.358	-0.196	0.148	-0.235
X10										1	-0.159	-0.307	-0.140	-0.421	-0.178	0.105	-0.156	-0.245
X11											1	-0.258	-.473*	-0.331	-0.433	-0.113	0.029	-0.281
X12												1	0.375	.948**	0.396	-0.171	0.028	0.265
X13													1	.500*	.968**	0.159	-0.045	.610**
X14														1	.523*	-0.148	0.160	0.392
X15															1	0.084	-0.104	.587*

X16																1	-0.154	-0.378
X17																	1	0.408
X18																		1
**. Correlation is significant at the 0.01 level (2-tailed).																		
*. Correlation is significant at the 0.05 level (2-tailed).																		

Note : X1=Plant Height 6 WAP, X1=Plant Height at Harvest, X1=biomass fresh Weight, X1= biomass dry Weight, number of tiller at 6 WAP, number of tiller at harvest, Number of leaves hill-1, Number of Panicles, Root Weight, shoot Weight, Root shoot Ratio, Grain weight hill-1, Weight of 1000 grains, Harvest Index, Yield Potential, Nitrogen Uptake in shoot, Phosphate Uptake in shoot, and Potassium Uptake in shoot.

Plant Height 6 MST negatively related to Plant Height at Harvest r =-0.649, biomass fresh Weight r =-0.505. However, it is positively related to the weight of 1000 grains r = 0.968, harvest index r = 0.523, yield potential r = 1.00, and potassium uptake at shoot r = 0.587. This indicates that the taller the 6-week-old plant when it reaches the maximum vegetatife phase, the higher the harvest index and 1000 grain weight as well as yield potential and Potassium absorption. This is because optimal plant growth is obtained from optimal Potassium uptake which affects transpiration and photosynthesis. This is also related to assimilates produced during plant growth and development which are stored in plant tissue and those produced in flag leaf translocated grain. So that the weight of 1000 grains becomes optimal. The weight of 1000 grains also shows the condition of the plants that get enough nutrients and water. This is in line with the results of [18], [24] states that the biomass fresh weight of plants is affected by plant height and leaf area, the higher the plant and leaf area, the biomass fresh weight will increase.

Plant height at harvest is negatively related to the weight of 1000 grains r = -0.521, and Yield Potential r = -0.649. the height of the plant at harvest is higher, the potential and weight of 1000 grains decreases, this is because if the plant is too tall, the number of tillers decreases and the panicles decrease which causes the yield potential to decrease. Also, the higher the plant, the distribution of asmylate to the grain decreases. So that the weight of 1000 grains decreases. This can be seen in tall rice with long internodes weighing 1000 grains which are small because the assimilate is not completely translocated to the grain.

Biomass fresh Weight is negatively related to Yield Potential r = -0.505. Biomass fresh weight has a negative relationship with yield potential, the higher the biomass fresh weight, the lower the yield potential. Because the biomass fresh weight is dominated by the vegetative parts and only a few yield organs or grain. This is also shown by the tall rice. So in certain circumstances it is necessary to shorten the internodes, So that assimilate is more widely distributed in the grain. This is in line with According to [25] rice husk biochar is an alternative soil amendment material, capable of increasing soil pH, C organic, and available P, as well as optimizing plant growth and production. [26] stated that rice husk biochar can improve soil physical properties; such as increasing cation exchange capacity (CEC) and soil organic matter. This causes an increase in plant height growth. According to [27] application of biochar can increase the availability of N nutrients for plants. More and more accumulation of organic carbon in the soil is also able to increase the availability of N for plants. So that it can increase the height of rice. Nutrients have a good effect on growth by increasing plant height, biomass fresh weight and biomass dry weight (roots, stems, leaves and number of lateral roots), besides that compost can also improve soil structure and aeration [28]. According to [29] the addition of nutrients in the soil can increase the wetness of the soil. [30] also stated that compost can improve soil physical properties such as improving aeration, being able to hold water and stimulating granulation. [31] stated that an increase in soil pH due to the application of biochar and compost resulted in more macro nutrients being available.

6 weeks old tillers positively related to the number of panicles r = 0.862. the more the number of tillers, the more the number of panicles, because 90% of the tillers are generally panicles. [32] shows that the combination of compost and biochar can add nitrogen to the soil and can also accelerate plant growth. productivity and the number of grains panicle^{-1}, as well as grain production plot^{-1} are affected by the application of organic fertilizers according to [33] states that the increasing number of tiller and panicle. Root dry Weight is positively related to Root shoot Ratio r = 0.874. The higher the root weight, the higher the root shoot ratio. This indicates that the roots are developing optimally or there is an environmental stress such as drought which causes the roots to grow deeper in drought condition. So that more assimilate is translocated to the roots. This results in higher root weight and increased root shoot ratio. This is in line with the statement of [7] that biochar encourages mechanisms that play a role in increasing plant growth and nutrients. The application of biochar can increase the N content in the soil, one of the benefits of N

for plants is to stimulate plant vegetative growth, such as stems, leaves and roots. According to [34] rice husk biochar can improve soil and increase crop productivity. Besides that, the addition of biochar in the soil can also increase the availability of nutrients in plants. With the availability of nutrients in the soil, plant roots can increase nutrient uptake. According to [35], N will be associated with the formation of chlorophyll in the leaves. So that it will increase the process of photosynthesis and stimulate the growth of the number of leaves in plants. The application of compost added with biological fertilizers can also increase the population of nitrogen fixing bacteria (N) and phosphate solubilizing bacteria in the soil [36].

The weight of grain per hill is positively related to the harvest index r = 0.94. Then the heavier the grain of the hill^{-1}, the higher the harvest index. Because the harvest index is the ratio between the weight of the grain and the weight of the shoot. It also shows the optimization of photosynthesis in the reproductive and maturation phases. Based on research by [37] husk biochar can increase chlorophyll content. This will increase the assimilate of the process of photosynthesis which is used for plant growth and development [38]. The weight of 1000 grains is positively related to yield potential r = 0.968, Potassium uptake at shoot r = 0.610. This is because the heavier the 1000 grains, the higher the yield potential because it is indicated by optimally developed grains due to sufficient carbohydrates formed from assimilate which are supported by optimal nutrient uptake of Potassium. Because Potassium is a catalyst for 60 kinds of enzymes, especially enzymes that help synthesize carbohydrates. This is in line with [39], stated that the application of compost has a positive effect in reducing the problem of Al poisoning in marginal soils and increasing the uptake of nutrients N, P, and K. The application of compost also adds soil organic matter thereby increasing the cation exchange capacity of the soil and influencing nutrient uptake by plants, even though the soil in acidic pH state. The role of organic matter does not only play a role in providing plant nutrients, but is more important in improving the physical, chemical and biological properties of the soil [40].

The harvest index is positively related to yield potential r = 0.52. the higher the harvest index, the higher the yield potential because the harvest index is the ratio of grains weight to shoot dry weight. So the heavier the grains produced in one hill, the higher the harvest index. This is in line with the results of the study [41] [42]. Yield potential is positively related to potassium uptake at shoot r = 0.587. This is because potassium is an enzyme catalyst for the formation of carbohydrates. So the higher the absorption of potassium, carbohydrates that are formed higher, the more translocated to the grain. So that the weight of the grain increases. This is in line with the results of the study of [43] said the addition of organic matter, especially compost, can increase the capacity of soil to hold water under a water deficit. Based on the results of research conducted by [44] that applying compost to corn plants as much as 7.5 to 15 tons ha^{-1} can increase the growth and production of corn.

IV. Conclusion

In newly opened rice fields that are given biochar soil amendments and manure can change the correlation between growth parameters of nutrient uptake. Higher Potassium absorption, can increase assimilate which can be transferred to plant tissues and yield organs. So that the yield potential increases. While the correlation between morphos agronomic parameters, in the form of biomass fresh weight is negatively correlated with yield potential, which indicates an imbalance between the sink and source parts of the plant. Plants that are balanced between sink and source have a balanced number of tiller. So that the yield potential increases because a lot of assimilate is translocated to the grains. The weight of the grains hill-1 and the weight of 1000 grains determines the yield potential of the plant. It also shows the optimality of the plant in obtaining a suitable growing environment. So that carbon accumulation is also balanced between the vegetative and generative parts. Knowing the correlation between morpho agronomic parameters and nutrient uptake of rice in newly cleared land can be used as a reference in selecting appropriate agronomic technique in newly paddy field to encrease rise yield in sustainable agriculture.

References

[1] Fao, "Food And Agriculture Organization Of The United Nations," Giews- Global Information And Early Warning System Of Food And Agriculture, 2019.

[2] A. Kasno, "Perbaikan Tanah Untuk Meningkatkan Efektivitas Dan Efisiensi Pemupukan Berimbang Dan Produktivitas Lahan Kering Masam," J. Sumberd. Lahan, Vol. 13, No. 1, Pp. 27–40, 2019.

[3] M. N. Hoque Et Al., "Organic Amendments For Mitigation Of Salinity Stress In Plants: A Review," Life, Vol. 12, No. 10, Pp. 1–2, 2022, Doi: 10.3390/Life12101632.

[4] P. P. A. Saifulloh, "Gagasan Konstitusi Pangan: Urgensi Pengaturan Hak Atas Pangan Warga Negara Dalam Amandemen Kelima Uud 1945," J. Ham, Vol. 12, No. 2, Pp. 227–243, 2021.

[5] M. Murdaningsih And A. F. G. Uran, "Kajian Agronomi Potensi Pengembangan Tanaman Sorgum Varietas Numbu Di Kabupaten Ende," J. Budid. Pertan., Vol. 17, No. 1, Pp. 23–27, 2021.

[6] F. Shalsabila, S. Prijono, And Z. Kusuma, "Pengaruh Aplikasi Biochar Kulit Kakao Terhadap Kemantapan Agregat Dan Produksi Tanaman Jagung Pada Ultisol Lampung Timur," J. Tanah Dan Sumberd. Lahan, Vol. 4, No. 1, Pp. 473–480, 2017.

[8] M. P. Tambunan, M. Dwi, M. Mannesa, And R. P. Tambunan, "Majalengka Dengan Penginderaan Jauh Metode Ndvi," Vol. 7, No. 1, Pp. 17–26, 2021.
[9] M. F. Anshori, B. S. Purwoko, I. S. Dewi, S. W. Ardie, W. B. Suwarno, And H. Safitri, "Determination Of Selection Criteria For Screening Of Rice Genotypes For Salinity Tolerance," Sabrao J. Breed. Genet., Vol. 50, No. 3, Pp. 279–294, 2018.
[10] S. Abel, A. Peters, S. Trinks, H. Schonsky, M. Facklam, And G. Wessolek, "Impact Of Biochar And Hydrochar Addition On Water Retention And Water Repellency Of Sandy Soil," Geoderma, Vol. 202, Pp. 183–191, 2013.
[11] S. D. Elvira, M. Yusuf, And M. Maiyuslina, "Karakter Agronomi Beberapa Varietas Sorgum Pada Lahan Marginal Di Aceh Utara," J. Agrium, Vol. 12, No. 1, 2015.
[12] A. Paiman And Y. G. Armando, "Potensi Fisik Dan Kimia Lahan Marjinal Untuk Pengembangan Pengusahaan Tanaman Melinjo Dan Karet Di Provinsi Jambi," Akta Agrosia, Vol. 13, No. 1, Pp. 89–97, 2010.
[13] R. P. Sari, T. Islami, And T. Sumarni, "Aplikasi Pupuk Kandang Dalam Meminimalisir Pupuk Anorganik Pada Produksi Padi (Oryza Sativa L.) Metode Sri." Brawijaya University, 2014.
[14] A. D. I. Oksifa, R. Harti, S. Salman, A. Atma, And W. Dan, "Pemanfaatan Jenis Pupuk Kandang Pada Berbagai Periode Kekeringan Terhadap Tanaman Padi (Oryza Sativa L .) Utilization Of Kind Mature Fertilizer In Drought Periode On Paddy Plant (Oryza Sativa L .)" Pp. 60–69.
[15] E. Kaya, "Pengaruh Kompos Jerami Dan Pupuk Npk Terhadap N-Tersedia Tanah, Serapan-N, Pertumbuhan, Dan Hasil Padi Sawah (Oryza Sativa L)," Agrologia, Vol. 2, No. 1, P. 288785, 2013.
[16] R. Rahmiati, "Pengaruh Pupuk Kandang Sapi Dan Kombinasi Pupuk Anorganik Terhadap Pertumbuhan Dan Produksi Tanaman Padi (Oryza Sativa L.)," Serambi Saintia J. Sains Dan Apl., Vol. 8, No. 2, Pp. 71–78, 2020.
[17] S. Hartati, J. Syamsiyah, And H. Widijanto, "Pengaruh Pupuk Kandang Sapi Dengan Biodekomposer Dan Pupuk Anorganik Terhadap Efisiensi Serapan K Dan Hasil Tanaman Padi (Oryza Sativa L.) Di Lahan Sawah Palur Sukoharjo," Sains Tanah-Journal Soil Sci. Agroclimatol., Vol. 6, No. 1, Pp. 53–60, 2009.
[18] K. Subatra, "Pengaruh Sisa Amelioran, Pupuk N Dan P Terhadap Ketersediaan N, Pertumbuhan Dan Hasil Tanaman Padi Di Musim Tanam Kedua Pada Tanah Gambut," J. Lahan Suboptimal J. Suboptimal Lands, Vol. 2, No. 2, 2013.
[19] S. Suswana, "Pengaruh Biochar Terhadap Pertumbuhan Padi Dalam Sistem Aerobik," Agrotechnology Res. J., Vol. 3, No. 1, Pp. 44–49, 2019.
[20] C. E. P. Putra, "Respon Pertumbuhan Dan Hasil Beberapa Varietas Padi (Oryza Sativa L.) Pada Berbagai Jenis Pupuk Kandang," Univ. Pgri Yogyakarta, 2015.
[21] Ses, Standard Evaluation System For Rice. Irri Los Banos Philipine, 2002.
[22] C. J. R. Kakanga, S. A. Nio, And P. Siahaan, "Rasio Akar: Tajuk Tanaman Padi Lokal Sulawesi Utara Yang Mengalami Cekaman Banjir Dan Kekeringan Pada Fase Vegetatif (Root: Shoot Ratio Of North Sulawesi Local Rice Under Waterlogging And Drought At The Vegetative Phase)," J. Bios Logos, Vol. 7, No. 1, 2017.
[23] F. H. Mohd Hanafi Et Al., "Environmentally Sustainable Applications Of Agro-Based Spent Mushroom Substrate (Sms): An Overview," J. Mater. Cycles Waste Manag., Vol. 20, Pp. 1383–1396, 2018.
[24] A. Kurniawan, B. Haryono, M. Baskara, And S. Y. Tyasmoro, "Pengaruh Penggunaan Biochar Pada Media Tanam Terhadap Pertumbuhan Bibit Tanaman Tebu (Saccharum Officinarum L.) The Effects Of Biochar Application To Planting Media On The Growth Of Sugarcane Seeds (Saccharum Officinarum L.)," J. Produksi Tanam., Vol. 4, No. 2, Pp. 153–160, 2016.
[25] D. A. Herhandini, R. Suntari, And A. Citraresmini, "Pengaruh Aplikasi Biochar Sekam Padi Dan Kompos Terhadap Sifat Kimia Tanah, Pertumbuhan, Dan Serapan Fosfor Tanaman Jagung Pada Ultisol," J. Tanah Dan Sumberd. Lahan, Vol. 8, No. 2, Pp. 385–394, 2021.
[26] S. K. Nisak And S. Supriyadi, "Biochar Sekam Padi Meningkatkan Pertumbuhan Dan Hasil Tanaman Kedelai Di Tanah Salin," J. Pertan. Presisi (Journal Precis. Agric., Vol. 3, No. 2, Pp. 165–176, 2019, Doi: 10.35760/Jpp.2019.V3i2.2345.
[27] H. Singh, B. Naik, V. Kumar, And G. S. Bisht, "Screening Of Endophytic Actinomycetes For Their Herbicidal Activity," Ann. Agrar. Sci., Vol. 16, No. 2, Pp. 101–107, 2018, Doi: 10.1016/J.Aasci.2017.11.001.
[28] R. Saraswati, T. Prihatini, And D. Hastuti, "Teknologi Pupuk Mikroba Untuk Meningkatkan Efisiensi Pemupukan Dan Keberlanjutan Sistem Produksi Padi Sawah," Tanah Sawah Dan Teknol. Pengelolaannya, Pp. 169–189, 2004.
[29] C. A. Corbino Et Al., "Equine Exploitation At Pompeii (Ad 79)," J. Archaeol. Sci. Reports, Vol. 48, No. March, P. 103902, 2023, Doi: 10.1016/J.Jasrep.2023.103902.
[30] A. Dariah, S. Sutono, L. Nurida, W. Hartatik, And E. Pratiwi, "Pembenah Tanah Untuk Meningkatkan Produktivitas Lahan Pertanian," 2015.
[31] W. Herman And E. Resigia, "Pemanfaatan Biochar Sekam Dan Kompos Jerami Padi Terhadap Pertumbuhan Dan Produksi Padi (Oryza Sativa) Pada Tanah Ordo Ultisol," J. Ilm. Pertan., Vol. 15, No. 1, Pp. 42–50, 2018.
[32] M. K. Azmi, "Pengaruh Sistem Irigasi, Biochar, Pupuk Hayati Dan Fitosan Terhadap Pertumbuhan, Hasil Tanaman Dan Efesiensi Irigasi Untuk Tanaman Sorgum Di Tanah Pasiran Lahan Kering Lombok Utara." Universitas Mataram, 2018.
[33] R. Harifia, M. Irham, And M. Rusdi, "The 4 Th International Conference On Agricultural Technology , Engineering , And Environmental Sciences (Icates) 2022 Letter Of Acceptance And Invitation Dear," No. 3, P. 2022, 2022.
[34] L. Huang Et Al., "Long-Term Combined Effects Of Tillage And Rice Cultivation With Phosphogypsum Or Farmyard Manure On The Concentration Of Salts, Minerals, And Heavy Metals Of Saline-Sodic Paddy Fields In Northeast China," Soil Tillage Res., Vol. 215, No. September 2021, P. 105222, 2022, Doi: 10.1016/J.Still.2021.105222.
[35] M. E. Kusuma, K. Kastalani, And K. Kristina, "Efektifitas Pemberian Kompos Trichoderma Terhadap Pertumbuhan Dan Produksi Rumput Brachiaria Humidicola Di Lahan Gambut," Ziraa'ah Maj. Ilm. Pertan., Vol. 44, No. 1, Pp. 20–27, 2019.
[36] S. T. Jeong, G. W. Kim, J. G. Lee, S. R. Cho, And P. J. Kim, "Composting And Compost Application: Trade-Off Between Greenhouse Gas Emission And Soil Carbon Sequestration In Whole Rice Cropping System," 한국토양비료학회 학술발표회 초록집, P. 225, 2018.
[37] I. Istiqomah, D. E. Kusumawati, A. D. Serdani, And F. A. Choliq, "Pemanfaatan Limbah Jerami, Sekam, Dan Urine Sapi Sebagai Pupuk Organik Untuk Meningkatkan Pertumbuhan Dan Produksi Padi," Viabel J. Ilm. Ilmu-Ilmu Pertan., Vol. 16, No. 2, Pp. 101–113, 2022.
[38] X. Song, H. Li, J. Song, W. Chen, And L. Shi, "Biochar/Vermicompost Promotes Hybrid Pennisetum Plant Growth And Soil Enzyme Activity In Saline Soils," Plant Physiol. Biochem., Vol. 183, Pp. 96–110, 2022.
[39] M. Majid, "Pertumbuhan Dan Hasil Beberapa Varietas Tanaman Padi (Oryza Sativa L.) Pada Tingkat Kondisi Kekeringan," J. Ilm. Mhs. Pertan., Vol. 1, No. 1, Pp. 176–187, 2016, Doi: 10.17969/Jimfp.V1i1.1011.

[40] B. S. A. Syahputra, M. Siregar, R. R. A. Tarigan, And B. Ketaren, "Hasil Dan Komponen Hasil Padi Dengan Sistem Integrasi Padi-Sawit Setelah Aplikasi Paclobutrazol (Pbz)," Agrium J. Ilmu Pertan., Vol. 21, No. 3, Pp. 223–229, 2018.

[41] C. N. Ichsan, R. Andani, B. Basyah, S. Zakaria, And E. Efendi, "The Relationship Between Relative Water Content Of Leaves, Soluble Sugars, Accumulation Of Dry Matter, And Yield Components Of Rice (Oryza Sativa L.) Under Water-Stress Condition During The Generative Stage," Int. J. Adv. Sci. Eng. Inf. Technol., Vol. 12, No. 3, Pp. 899–907, 2022, Doi: 10.18517/Ijaseit.12.3.13311.

[42] C. N. Ichsan, W. S. Mahfira, A. Halim, And J. Juliawati, "Mitigation Of Drought Disaster In Sorghum (Sorghum Bicolor L. Moench) In Ultisol Soil With Application Of Soil Amendments And Npk For Diversification And Improvement Of Food Security," In Iop Conference Series: Earth And Environmental Science, 2023, Vol. 1183, No. 1, P. 12076.

[43] T. A. A. El-Mageed, I. M. E.- Samnoudi, A. E. M. Ibrahim, A. R. Abd, And E. Tawwab, "Compost And Mulching Modulates Morphological , Physiological Responses And Water Use E Ffi Ciency In Sorghum (Bicolor L . Moench) Under Low Moisture Regime," Agric. Water Manag., Vol. 208, No. February, Pp. 431–439, 2018, Doi: 10.1016/J.Agwat.2018.06.042.

[44] A. Situmorang, A. Zannati, And D. Widyajayantie, "Cekaman Salinitas Berdasarkan Karakter Multivariat Pertumbuhan Dan Biokimiapadafase Vegetatif 1 [Identification Of Salt Tolerance And Salt Sensitivity Of Insertional Mutant Rice Lines Based On Multivariate Growth And Biochemical Characters At Vegetative," Vol. 10, No. April, Pp. 471–480, 2011.