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Research Article

Effects of ameliorant and fertilizer on the growth and yield of maize grown in peatlands soil of West Kalimantan, Indonesia

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Abstract: The use of agricultural lime ameliorant or rice husk charcoal combined with inorganic fertilizers is one of the agricultural intensification efforts in peatlands. This study aimed to find out the influence of various ameliorant types and nitrogen, phosphorus, and potassium inorganic fertilizer doses application on growth and yield of maize in peatlands soil was conducted in Siantan Hulu Village, Pontianak City, West Kalimantan used. This study used a split-plot design with the main plot of ameliorant types (A) consisting of three treatments, i.e. without ameliorant (A0), agricultural lime of 3 t/ha (A1) and rice husk charcoal of 3 t/ha (A2). The subplot was inorganic fertilizer doses (B) consisting of three treatments i.e. B1 = 50% of N, P, and K inorganic fertilizers, B2 = 75% of N, P, and K inorganic fertilizer, and B3 = 100% of N, P, and K inorganic fertilizers. Observation on crop growth consisted of crop height, number of leaves, leaf area, crop total fresh weight, crop total dry weight, and crop growth rate. Yield observation consisted of ear length, ear diameter, 100-dry seed weight, seed yield weight per hectare, and harvest index (IP). The results of the study indicated that rice husk charcoal application of 3 t/ha gave seed yield weight of 7.25 t/ha that was higher than that of agricultural lime that produced 6.34 t/ha seed yield and without ameliorant that produced the lowest seed yield of 4.18 t/ha. Application of N, P, and K inorganic fertilizer dose of 75% produced an insignificant difference seed yield compared to the dose of 100%, which were 6.32 t/ha and 6.69 t/ha, respectively. Therefore, the application of N, P, and K inorganic fertilizer dose of 75% is recommended as a basic of maize fertilization.

Keywords*: ameliorant, inorganic fertilizers, maize yield improvement, peatlands*

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Introduction

Food self-sufficiency is the key to national food security. In order to achieve food self-sufficiency and security, the government has set a sustainable self-sufficiency target for maize commodity based on the strategic plan of the Ministry of Agriculture in 2015-2019 of 22.36 million ton (Ministry of Agriculture, 2015). Efforts in increasing national maize production are carried out every year since the demand on the commodity is increasing along with the increase in population growth rate that is faster than the growth in maize production. The efforts can be made through intensification as well as extensification. Limitation in productive land directs agricultural extensification to marginal lands including peatlands that are potential for maize development.

Indonesia has the broadest peat lands among the tropical countries, which is about 21 million ha or 10.8% of land area in Indonesia. Most of the peatlands are located in the four largest islands, which is 35% in Sumatera, 32% in Kalimantan, 30% in Papua, and a small part in Sulawesi,

Halmahera, and Seram of 3% (Radjaguguk, 1995). The development of peatlands as agricultural land faces obstacles because of the low content of macro and micronutrients available for a plant, high soil acidity level, high cation exchange capacity, and low base saturation. Organic acids in peatlands could have positive as well as negative influences on plant growth and development. The main compounds in peatlands are hemicellulose, cellulose, and lignin. Lignin biodegradation that could produce phenolic acids, whereas cellulose or hemicellulose produces carboxylate acids. Phenolic acids are organic compounds that are toxic to plants (Tan, 1986).

An effort to overcome peat lands issues is by utilizing ameliorant materials of agricultural lime or rice husk charcoal combined with inorganic fertilizers to improve peatland condition and increase pH and the availability of nutrients in the soil thus it can improve soil and maize crop productivity. Sinaga (2010) indicated that rice husk charcoal could increase soil pH thus increase P available and soil water holding capacity. Rice husk charcoal application in a dose of 10t/ha without fertilizers could give better result in soybean and maize growth experiments. According to Agus and Subiksa (2008), the management of soil fertility in peatlands having low pH can be done by the application of ameliorant in the form of lime with a dose of 1-3 t/ha per year to increase soil pH. The ideal pH level for nutrients availability in peatland is 5.5 since after pH of 4.8-5.0 is achieved the curve of pH increase with the application of lime tends to level.

This study aimed to elucidate the influence of various ameliorant types and the combination of N (nitrogen), P (phosphorus), and K (potassium) inorganic fertilizers application on the growth and yield of maize grown in peatlands, and to obtain the best combination of the ameliorant and the N, P, and K inorganic fertilizers.

Materials and Methods

The study was conducted in Siantan Hulu Village, Pontianak City, West Kalimantan in September 2017 – January 2018. Pearland characteristic used was hemic peat. Hemic peat is peat with moderate weathering level (half-mature) and partly weathered, and its original material still can be recognized with dark brown colour and peat thickness of 50-200 cm from the soil surface (Subagjo, 2002). Materials used in this study consisted of maize seeds of Sukmaraga variety, inorganic fertilizers (Urea, SP36, and KCl), ameliorant materials (rice husk charcoal and agricultural lime), pesticides, and insecticides. This study used a split-plot design with 3 (three) replicates. The experimental unit plot size was 2 m x 4 m, and there were 27 (twenty-seven) experimental plots. The main plot was a type of ameliorant (A) consisting of three treatments, i.e. without ameliorant (A0), agricultural lime of 3 t/ha and rice husk charcoal of 3 t/ha (A2). The subplot (B) was inorganic fertilizer doses (B), consisting of three treatments i.e. B1 = 50 % of N, P and K inorganic fertilizers or equal to 153.34 kg N/ha, 50 kg P_2O_5 /ha, and 50 kg K_2O /ha; B2 = 75 % N, P and K inorganic fertilizers or equal to 230.00 kg N/, 75 kg P_2O_5/ha, and 75 kg K_2O/ha; and B3 = 100 % N, P and K inorganic fertilizers or equal to 306.67 kg N/ha, 100 kg P_2O_5 /ha, and 100 kg K_2O/ha. Observations on crop growth consisted of crop height, number of leaves, leaf area, plant total fresh weight, crop total dry weight, and crop growth rate (LPT). Yield observations consisted of ear length, ear diameter, 100-dry seed weight, seed yield weight, and harvest index (IP). Environmental measurements during the study were rainfall, humidity and daily air temperature. Data obtained were analyzed using F-test at a significance level of 5%, followed by LSD (least significant difference) test at5% to find out the differences in each treatment.

Results and Discussion

Crop growth and crop height

Results of variance analysis on maize height parameter at 40-82 days after planting did not show a significant difference in all treatments tested (Table 1). Information from the West Kalimantan Assessment Institute for Agricultural Technology (BPTP) indicated that the genetic factors were more dominant toward the height of maize of Sukmaraga variety thus the height was the same in every treatment tested.

Number of leaves per crop

The number of leaves is one of crop growth indicators. In this case, the number of leaves per crop measurement describes crop ability to produce assimilates. In Table 2, the analysis of variance results indicated that ameliorant treatments in all observation ages gave no significant influence on the number of leaves formed. However, the treatment of N, P, and K inorganic fertilizers at a dose of 100% showed a higher number of leaves in the growth phase of 68 and 82 days after planting compared to the doses of 50% and 75%. These results could indicate that possibility of the increase of nutrient absorption in the higher doses of inorganic fertilizer, where the

application of 100% of N, P, and K inorganic fertilizers produced a higher number of leaves at generative phase (68 and 82 days after planting) than in the vegetative phase. Thesis in line with Jumini et al. (2011) statement that N, P, and K nutrients are essential nutrients for plants as well as the limiting factors for plant growth. An increased dose of N fertilization to soil has a direct role in plant vegetative parts formation or growth and plays an important role in chlorophylls formation to increase photosynthesis process and in turn, it will increase plant growth, such as stem, root, and leaves. In addition, Lingga and Marsono (2007) stated that the P element accelerates flowering and maturation of seeds and fruits. Whereas, K element strengthens parts of the plant body, such as leaves, flowers and fruits so that they do not easily fall, improves plant endurance toward drought and diseases, and improves the quality of seeds.

Table 1. Mean of maize length per crop due to the application of various ameliorant types and N, P, and K inorganic fertilizers

Treatments	**Crop length (cm), at observation age of days after planting (DAP)**			
	40	**54**	**68**	**82**
Ameliorant types				
Without ameliorant	140.86	241.20	286.20	275.22
Agricultural lime	148.90	244.54	287.89	282.09
Rice husk charcoal	153.12	259.67	297.80	293.69
5% LSD	ns	ns	ns	ns
Doses of inorganic fertilizers				
50 % N, P and K fertilizers	145.76	246.66	292.24	283.36
75 % N, P and K fertilizers	150.61	248.43	286.58	284.67
100 % N, P and K fertilizers	146.50	250.32	293.07	282.98
5% LSD	ns	ns	ns	ns

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to 5%LSD (least significance different test), DAP (days after planting), ns = not significant

Table 2. Mean of the number of leaves of maize per crops due to the application of various ameliorant types and N, P, and K inorganic fertilizers

Treatment	**Number of leaves, at observation age of days after planting (DAP)**			
	40	**54**	**68**	**82**
Ameliorant types				
Without ameliorant	5.40	8.00	9.84	8.49
Agricultural lime	5.44	8.76	10.29	8.93
Rice husk charcoal	5.31	9.33	11.11	9.82
5% LSD	ns	ns	ns	ns
Doses of inorganic fertilizers				
50 % N, P and K fertilizers	5.29	8.67	9.87 a	8.38 a
75 % N, P and K fertilizers	5.31	8.58	10.20 a	9.02 a
100 % N, P and K fertilizers	5.56	8.84	11.18 b	9.84 b
5% LSD	ns	ns	0.97	0.70

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to 5% LSD (least significance different test), DAP (days after planting), ns = not significant

Leaf area per crop

Leaf area will determine the amount of photosynthate produced from photosynthesis process. The photosynthate is used for plant growth and development. Based on the data presented in Table 3, application of various ameliorant types gave a significant influence only at the age of 40 days after planting, where 5% LSD test indicated that agricultural lime and rice husk charcoal produced the same leaf area and that was significantly higher than that of without

ameliorant. Widowati et al. (2012) reported that leaf area was better with the application of biochar than that with the application of KCl only. The applied biochar can improve soil physical, chemical, and biological properties Verdiana et al. (2016) found that rice husk biochar application of 4 t/ha and 2 t/ha, as well as NPK of 300 kg, gave higher leaf area than treatment without biochar with the same NPK fertilizer doses. Data presented in Table 3 indicate that N, P, and K inorganic fertilizer treatments showed a significant difference between three treatments with higher dose produced higher leaf area in vegetative phase at the age of 40 days after planting. However, in generative phase at the age of 68 and 82 days after planting, application of 100% dose of N, P, and K inorganic fertilizers resulted in higher leaf area compared to doses of 50% and 75%. This is in line with the findings of Gardner et al. (1991) that maximum plant leaf area is achieved in its early life cycle and after that, the increase in leaf area remains the same along with the decrease of a status called as critical leaf area. However, upon entering the generative phase, there is a tendency of a significant increase in leaf area due to plant life cycle phase that has been passed.

Table 3. Mean of leaf area per crop due to the application of various ameliorant types and N, P, and K inorganic fertilizers

Treatment	**Leaf area (cm^2), at observation age of days after planting (DAP)**			
	40	**54**	**68**	**82**
Ameliorant types				
Without ameliorant	894.63 a	4703.98	7198.17	6449.51
Agricultural lime	1175.92 b	4978.14	7531.21	6731.50
Rice husk charcoal	1317.91 b	4952.66	8162.03	7380.72
LSD	278.69	ns	ns	ns
Doses of inorganic fertilizers				
50 % N, P and K fertilizers	993.95 a	4827.16	7344.37 a	6009.11 a
75 % N, P and K fertilizers	1131.31 b	4659.86	7406.35 a	6616.36 a
100 % N, P and K fertilizers	1263.19 c	5147.76	8140.69 b	7936.25 b
5% LSD	107.46	ns	646.48	1101.92

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to 5% LSD (least significance different test), DAP (days after planting), ns = not significant

Crop total fresh weight

Results of analysis of variance analysis indicated that ameliorant type treatment gave a significant influence on the crop at 40-82 days after planting. N, P, and K fertilizers gave a significant effect influence only on the crop at 40-54 days after planting (Table 4). Application of rice husk charcoal ameliorant produced the highest fresh weight compared to without ameliorant and agricultural lime treatments at vegetative growth phase of 40 – 54 days after planting. During the generative phase at 68-82 days after planting, lime and rice husk charcoal treatments resulted in no different crop total fresh weight. The treatments, however, resulted in higher crop total fresh weight than that of without ameliorant treatment. In this case, ameliorant application was capable in improving soil chemical properties thus creating a better condition for crop growth. According to Supriyanto and Fiona (2010), husk charcoal is a soil amendment material that can improve soil properties for land rehabilitation efforts. Application of 100% dose of N, P, and K inorganic fertilizers produced higher crop total fresh weight at 40 and 54 days after planting compared to the application of 50% and 75% doses of N, P, and K fertilizers. Taufiq (2014) stated that each nutrient has different function for plant, among others: 1) Nitrogen plays role as chlorophyll composer and it is the main component of amino acids in protein formation; 2) Phosphorus plays role as cell membrane composer and it is ATP (adenosine triphosphate) compound component and ADP (deoxyribonucleic acid) and RNA (ribonucleic acid) composer in cell division; 3) Potassium plays a role in translocation and accumulation of formed carbohydrate compounds, arranging stomata opening and closing, and maintaining turgor pressure in cells (protect plant from disease attack).

Table 4. Mean of crop total fresh weight due to the application of various ameliorant types and N, P, and K inorganic fertilizers

Treatment	Crop total fresh weight (g), at observation age of days after planting (DAP)			
	40	54	68	82
Ameliorant types				
Without ameliorant	140.67 a	241.44 a	404.00 a	427.33a
Agricultural lime	182.22 b	386.00 b	583.33 b	592.11b
Rice husk charcoal	227.33 c	483.56 c	588.56 b	624.22b
5% LSD	41.14	83.12	144.88	133.19
Doses of inorganic fertilizers				
50 % N, P and K fertilizers	142.00 a	276.67 a	481.33	484.44
75 % N, P and K fertilizers	168.78 a	350.11 b	547.11	572.78
100 % N, P and K fertilizers	239.44 b	484.22 c	547.44	586.44
5% LSD	44.17	73.12	ns	ns

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to DAP (days after planting), ns =not significant

Crop total dry weight

Crop growth can be measured by the increase in crop total dry weight produced. Crop total dry weight describes the net result of photosynthesis indicated as dry weight. Based on variance analysis result, it can be seen that treatments of ameliorant types and N, P, and K inorganic fertilizers doses had significant influence at crop age of 40-82 days after planting (Table 5). Data presented in Table 5 indicate that at 40, 68, and 82 days after planting, agricultural lime and rice husk charcoal treatments produced the same total dry weight that was significantly higher than without ameliorant treatment. However, at 54 days after planting, the three treatments showed a significant difference with rice husk charcoal application that produced the highest crop total dry weight compared to two other treatments. This indicates that maize cultivation in peatlands requires ameliorant application as soil amendment material. This is following Ambak et al. (1991) that liming and micronutrients application increase maize production. Inorganic fertilizer dose treatments (100%, 75% and 50%) presented in Table 4 indicated that in vegetative phase at 40 – 54 days after planting, the three doses tested indicated that the higher the doses applied the more significant the increase in crop total dry weight. However, in generative phase at 68-82 days after planting, inorganic fertilizer dose treatments of 75% and 100% produced similar crop total dry weight but it was higher than that of 50% treatment that produced the lowest crop total dry weight.

Table 5. Mean of crop total dry weight due to the application of various ameliorant types and N, P, and K inorganic fertilizers

Treatments	Crop total dry weight (g), at observation age of days after planting (DAP)			
	40	54	68	82
Ameliorant types				
Without ameliorant	10.13 a	27.02 a	95.28 a	130.44 a
Agricultural lime	15.01 b	38.66 b	130.17 b	184.33 b
Rice husk charcoal	15.94 b	47.21 c	138.14 b	197.67 b
5% LSD	2.95	6.67	28.81	41.92
Doses of inorganic fertilizers				
50 % N, P and K fertilizers	11.13 a	28.61 a	102.59 a	143.78 a
75 % N, P and K fertilizers	13.55 b	36.40 b	123.08 b	192.11 b
100 % N, P and K fertilizers	16.39 c	47.88 c	137.91 b	176.56 b
5% LSD	2.15	6.99	20.10	30.85

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to 5% LSD (least significance different test), DAP (days after planting)

The phenomenon is understandable since crop dry weight is the manifestation of nutrients absorbed by root and the produced photosynthate (Sitompul and Guritno, 1995). The amount of crop total dry weight produced during vegetative phase indicates the high or low harvest production obtained.

Crop growth rate

Crop growth rate can be used to measure plant initial biomass productivity and efficiency that functions as stock in producing crop new materials. Data presented in Table 6 show that at 40-54, 54-68, and 68-82 days after planting. Application of agricultural lime and rice husk charcoal produced the same growth rate value but it was significantly higher than without ameliorant treatment. The results of this study showed that maize applied with agricultural lime and husk charcoal gave better growth rate than that without ameliorant. At the vegetative phase (40-54 days after planting), application of N, P, and K doses of 100% produced the highest growth rate (Table 5). At generative phase (54-68 days after planting), application of N, P, and K doses of 75% and 100% produced a similar growth rate value but it was significantly higher than that of N, P, and K doses of 50%. According to Simane et al. (1993) plants with relatively higher growth rate have the opportunity to obtain more significant resources compared to those with a slower rate. On the other hands, plants with lower growth rate have relatively low resources need that will decrease the distribution rate of dry material from leaves to seeds (Masdar, 2006).

Yield components

Ear length and diameter

Variance analysis results presented in Table 7showedthat application of agricultural lime and rice husk charcoal yielded similar maize ear diameter, and it was significantly different to that without ameliorants that had lower maize ear diameter. Application of N, P, and K inorganic fertilizer doses of 75% and 100% yielded similar maize ear length value but the value was significantly higher than that of inorganic fertilizer dose of 50%. However, the treatment of inorganic fertilizer dose of 100% had the highest maize ear diameter compared to that of 50% and 75% doses that had similar maize ear diameter values.

Table 6. Mean of crop growth rate due to the application of various ameliorant types and N, P, and K inorganic fertilizers

Treatments	**Crop growth rate (g/cm^2/day), at observation age of days after planting (DAP)**		
	40 – 54 DAP	**54 – 68 DAP**	**68 – 82 DAP**
Ameliorant types			
Without ameliorant	0.00081 a	0.00297 a	0.00177 a
Agricultural lime	0.00126 b	0.00430 b	0.00289 b
Rice husk charcoal	0.00160 b	0.00475 b	0.00303 b
5% LSD	0.00034	0.00118	0.00082
Doses of inorganic fertilizers			
50 % N, P and K fertilizers	0.00084 a	0.00323 a	0.00233
75 % N, P and K fertilizers	0.00125 b	0.00411 b	0.00265
100 % N, P and K fertilizers	0.00158 c	0.00469 b	0.00271
5% LSD	0.00030	0.00078	Ns

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to 5% LSD = least significance different, DAP = days after planting, ns = not significant

100-seed weight, seed yield weight per hectare and harvest index

Variance analysis result on each treatment indicated that application of various ameliorant types gave no significant influence on 100-seeds weight parameter, whereas treatments of N, P, and K inorganic fertilizer doses indicated a significant influence on 100-seeds weight (Table 8). Data presented in Table 8 indicate that inorganic fertilizer doses treatment of 75% and 100% had a higher 100-seed weight that was significantly different from the treatment of inorganic fertilizer dose of 50%. 100-seed weight is a parameter indicating endosperm size in seeds (reference?). Rahni (2012) stated that the increase in seed dry weight relates to the amount of photosynthate translocation into the seeds and a better plant root system to absorb nutrients from the soil.

Table 7. Mean of maize ear length and diameter due to the application of various ameliorant types and N, P, and K inorganic fertilizers

Treatment	Maize ear length (cm)	Maize ear diameter (cm)
Ameliorant types		
Without ameliorant	15.69 a	3.96 a
Agricultural lime	18.01 b	4.31 b
Rice husk charcoal	19.03 b	4.50 b
5% LSD	1.12	0.22
Doses of inorganic fertilizers		
50 % N, P and K fertilizers	15.68 a	4.08 a
75 % N, P and K fertilizers	18.21 b	4.29 a
100 % N, P and K fertilizers	18.84 b	4.41 b
5% LSD	1.01	0.17

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to 5% LSD = least significance different

Table 8. Mean of 100-seed weight, dry seeds yield per hectare and maize harvest index due to the application of various ameliorant types and of N, P, and K inorganic fertilizers

Treatments	100 maize dry seeds weight (g)	Seed yield weight (t/ha)	Harvest index (%)
Ameliorant types			
Without ameliorant	25.77	4.18 a	0.29 a
Agricultural lime	26.26	6.34 b	0.36 b
Rice husk charcoal	30.53	7.25 c	0.42 c
5% LSD	ns	0.89	0.05
Doses of inorganic fertilizers			
50 % N, P and K fertilizers	25.55 a	4.85 a	0.33 a
75 % N, P and K fertilizers	28.32 b	6.32 b	0.37 b
100 % N, P and K fertilizers	28.69 b	6.59 b	0.39 b
5% LSD	1.96	0.63	0.04

Note: Numbers followed with the same letters in the same column indicate insignificant difference according to 5% LSD = least significance different, ns =not significant

A substantial photosynthate translocation into reproductive organs causes better ear formation and seed replenishment; thus the formed seeds are pithy with the larger size. Results of variance analysis using 5% LSD as indicated in Table 8 show that the three ameliorant treatments tested gave a significant different Seed yield weight per hectare where rice husk charcoal gave the highest seed yield of 7.25 t/ha which was a 73.44 % increase. The agricultural lime application gave a seed yield of 6.34 t/ha or 51.67% increase compared to without ameliorant treatment that resulted in seed yield of 4.18 t/ha. Based on variance analysis, application of N, P, and K inorganic fertilizer doses of 75% and 100% gave similar seed yield per hectare; however, it was significantly higher than that of 50% dose. Treatments of 75% and 100% inorganic fertilizer doses were capable in increasing seed yield of 30.31 % – 35.87 % compared to the application of 50% inorganic fertilizer. Analysis result for rice husk charcoal indicated that charcoal contained macronutrients (N = 0.52%, P = 0.40%, K = 0.68%) and micronutrients (Mg = 0.07 %, Fe = 429.90 ppm, Mn = 217.92 ppm, Cu = 3.59 ppm, Zn = 43.09 ppm) and had pH of 6.82. Rice husk charcoal served as soil binder; thus nutrients bond to soil could be split and then absorbed by the roots. This is in line with Masulili et al. (2012) report that rice husk charcoal increased pH and absorbed toxic or excess compounds and was able to give good aeration and drainage. Nutrients addition through N, P, and K inorganic fertilization increased the availability of N, P, and K elements in plants. In the generative phase, the formation of maize seeds and seed weight is inseparable from the role of nutrients in the soil and through fertilizers addition. In this phase, P and K macro elements play active roles since P element accelerates flowering, seed, and fruit ripening. K element strengthens plant body parts, such as leaves, flowers and fruits so they do not easily fall, improves plant endurance

toward drought and diseases, and improves the quality of fruit seeds (Lingga and Marsono, 2007). Harvest index is the ratio of seed dry weight to total crop dry weight. The results of this study indicated a significant influence between the three treatments tested. The application of rice husk charcoal produced the highest maize harvest index value (0.42) compared to agricultural lime treatment (0.36) and without ameliorant treatment (0.29). Application of N, P, and K inorganic fertilizer doses of 75% and 100% resulted in a similar maize harvest index value that was higher than and significantly different to the treatment of N, P, and K inorganic fertilizer dose of 50% (Table 8). According to Goldsworthy and Fisher (1992), the optimal harvest index value varies from 0.15 to 0.52. According to the Food Crop Research Center Bogor, the harvest index value for maize in the tropical area is about 0.39 (Wahyudin et al. 2015). The index value can be determined by total dried maize yield, 100-seed weight and leaf area index. The results of this study indicated that harvest index values obtained fulfilled the optimal harvest index criteria and husk charcoal treatment gave the highest harvest index value that was related to the highest seed yield weight per crop, per harvest plot and per hectare obtained in the treatment compared to other treatments.

Conclusion

The results from this experiment showed that the ameliorant treatment of husk charcoal and agricultural lime gave better vegetative and generative growths compared to those without ameliorant. Likewise, treatment of 75% and 100% inorganic fertilizer doses gave better growth and yield compared to 50% inorganic fertilizer dose. The rice husk charcoal application of 3 t/ha resulted in seed yield of 7.25 t/ha that was higher than that with the application of agricultural lime and without ameliorant, which were6.34 t/ha, and 4.18 t/ha, respectively. Whereas, the application of 75% N, P, and K inorganic fertilization doses produced insignificantly different seed yields compared to 100% dose, which were 6,32 t/ha and 6.69 t/ha, respectively. Therefore, the application of 75% N, P, and K inorganic fertilization dose is recommended as basic for maize fertilization.

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