INFLUENCE OF INTEGRATED SOIL FERTILITY MANAGEMENT ON THE VEGETATIVE GROWTH PARAMETERS OF *ZEA MAYS* IN THE GUINEA SAVANNA ECO-ZONE OF GHANA

Abukari Ammal[1*], Akwasi Adutwum Abunyewa[2] and Edward Yeboah[3]

[1]Department of Forestry and Forest Resources Management, Faculty of Natural Resources and Environment, University for Development Studies, Tamale, Ghana
[2]Department of Agroforestry, College of Agriculture and Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[3]Council for Scientific and Industrial Research – Soil Research Institute Kwadaso, Kumasi, Ghana

Abstract: All over the world, attention has been drawn to the use of eco-friendly biochar application to improve crop productivity. In Ghana, there are available potential feedstocks left unused and can be used for the production of biochar. Therefore, this study investigated the effect of different rates of rice husk biochar and different rates of inorganic nitrogen (N) on the growth of *Zea mays* in Nyankpala, Northern Ghana. Field experiments were conducted in the cropping period of 2012. The treatments involved 4 different rates of inorganic nitrogen fertilizer (0 kg Nha^{-1}, 30 kg Nha^{-1}, 60 kg Nha^{-1} and 90 kg Nha^{-1}) and 3 different rates of rice husk biochar (0 ton ha^{-1}, 2 ton ha^{-1} and 4 ton ha^{-1}). The treatments were allocated in a split-plot design with three replications. The vegetative parameters assessed were the number of leaves, plant height and plant girth. Treatments showed a significant ($p < 0.05$) influence on all the traits considered. The combined effects of inorganic nitrogen fertilizer and rice husk biochar significantly influenced the vegetative growth parameters of *Zea mays* with the maximum values recorded at 4 ton ha^{-1} rice husk biochar. Yet, this observation corresponds with 2 ton ha^{-1} rice husk biochar which recorded optimum growth parameters compared to the control. Within the limit of this work, it was concluded that growth parameters of *Zea mays* in the Guinea Savannah Eco-Zone of Ghana could significantly be improved by applying 4 ton ha^{-1} rice husk biochar. Integrated soil fertility management (ISFM), a prudent combination of inorganic fertilizers and residues from various sources to sustain the environment is currently a necessity. The experiment revealed that the application of rice husk biochar can improve the growth parameters of *Zea mays*. Yet, further experiments need to be done using

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*Corresponding author: e-mail: aammal@uds.edu.gh

higher rates of rice husk biochar to ensure the appropriate rate of biochar application.

Key words: rice husk biochar, maize, inorganic fertilizer, integrated soil fertility management, savanna, vegetative growth.

Introduction

Zea mays is the crop with the highest yields per hectare and the second largest commodity crop after cocoa in Ghana. The crop is high yielding and has diversified uses. About 70% of the total maize was produced by small-scale farmers. Average maize yields fluctuate between 1.2 metric ton ha^{-1} and 1.9 metric ton ha^{-1}, whereas on-station and on-farm trials suggest that yields averaging between 4 and 6 metric ton ha^{-1} of maize are attainable in the country. The maize supply in Ghana has been increasing steadily over the past few years with an average supply at 1.4 million metric ton over the period 2005–2010 (Ragasa et al., 2014). However, human consumption is rising and competing with the poultry industry and to a lesser extent with the livestock industry. Consequently, the production of maize needs to be increased by adopting integrated soil fertility management practices. Lately, a rising consent has emerged on the need for the application of integrated soil fertility management practices to reverse the negative nutrient balances in cropping systems in agriculture in sub-Saharan Africa (SSA) (Vanlauwe et al., 2015). This know-how can improve soil health, keep land alive and sustain its productive capacity. Biochar is a pyrolyzed by-product of biomass produced at high temperatures (>400°C) with little or no available oxygen. According to international biochar initiatives (IBIs), it is persistently utilised for its agricultural and environmental advantages. It is fine-grained, carbon-rich and porous material which basically consists of nano-structured aromatic compounds systematically arranged like graphite (Sohi et al., 2010). Nearly any type of organic resources can be pyrolyzed into biochar including various types of forest residues (sawdust) (Xu et al., 2012), agricultural residues (corn cob, corn stalk, wheat straw, rice straw, stalk of pearl millet, cotton, mustard, soybean, and sugar beet tailing) (Jindo et al., 2014; Yu et al., 2014; Prabha et al., 2015), and agro-industrial waste (paper mill waste, Jatropha husk, coffee husk, coconut shell and cocoa pod husk) (Dume et al., 2015; Prabha et al., 2015; Munongo et al., 2017). The waning in soil productivity due to increased intensity with low fertilizer inputs has been recognised as one of the core causes of food insecurities in Ghana. To attain food sufficiency, there is an urgent need to manage hitches in soil infertility, advancing crop production in these soils that are essential for social and economic explanations. Applying inorganic fertilizers affords an alternative to overcome soil infertility. However, the sole application of inorganic fertilizers causes degradation of soil health and decreases its productive capacity. The application of organic sources reduces the reliance on

expensive fertilizers that sustain and reduce nutrient losses and enhances biological N-fixation. When applied repetitively, soil organic matter accumulates, thus providing a capital of nutrients released slowly, increasing soil buffering capacity (balance between cations and anions), as well as capacity to hold up water (Sheahan and Barrette, 2014). The accumulation of nutrients and buffering capacity are slow processes and their potential benefits are likely to become visible in a long-standing case. The objective of the investigation was, however, to assess the effect of rice husk and inorganic nitrogen fertilizer on the maize growth parameters.

Materials and Methods

Site description

The field experiment was established throughout the 2012 cropping season at the experimental fields of Savannah Agriculture Research Institute (SARI), Nyankpala in the Northern region of Ghana. The site is located between latitude $9^o 25'$ N and longitude $00^o 58'$ W. The area has a rain forest belt with an average rainfall of about 1100 mm and a mean temperature range of 33° C to 39° C (SARI, 2016). The soil of the experimental site was sandy loam and slightly acidic (Table 1).

Table 1. Initial chemical and physical properties of soil.

Parameters	values
pH (1:1H$_2$O)	6.22
OC (%)	0.62
N (%)	0.62
P (mg kg^{-1})	4.92
K (mg kg^{-1})	0.16
ECEC (mg kg^{-1})	2.89
% base saturation	97.00
Sand (%)	62.85
Silt (%)	33.82
Clay (%)	3.33
Texture class	Sandy loam

Biological materials

Seeds for this experiment were collected from a local variety of maize (Dorke SR). However, the rice husk was collected in Nyankpala in the northern region of Ghana. Rice husk biochar was obtained after pyrolysis at 500°C using the drum type pyrolyzer (Gul et al., 2015).

Experimental design and treatment

The experiment was carried out in a split-plot design with 12 treatments, each of which was replicated 3 times. Treatments included the application of 0 ton ha^{-1}, 2 ton ha^{-1} and 4 ton ha^{-1} rice husk biochar and four levels of inorganic nitrogen fertilizer: 0 kg Nha^{-1}, 30 kg Nha^{-1}, 60 kg Nha^{-1} and 90 kgNha^{-1}. Soil preparing comprised a single ploughing and harrowing. The experimental area was 50 m x 50 m (2500 m^2) and was subdivided into 3 whole plots of 12.8 m x 12.8 m and each whole plot consisted of 4 sub-plots of 6.4 m x 6.4 m with a working path of 2.0 m in the whole plot and a working path of 1 m in the sub-plot. The biochar was mixed thoroughly with soil at a depth of 10 cm using a hoe (Venkateshet al., 2015) before planting whilst the basal application of triple superphosphate and muriate of potash was incorporated before planting to ensure a sufficient amount of essential nutrients in the soil. Nitrogen in the form of urea was split-applied: 1/3 at 1 week after planting and 2/3 weeks after planting (WAP). Four seeds were planted per seed-bed. Refilling was done 1 week after planting. Maize seedlings were thinned to 2 plants per seed-bed and a spacing distance of 80 cm x 40 cm with a plant population size of 62,500 plants ha^{-1}. Weeding was done 2 times within the cropping season; the first at 3 WAP and the second at 7 WAP (Table 2).

Table 2. Details of treatment combination.

Treatment symbol	Treatment combination
T_1	0 ton ha^{-1} Rice husk biochar + 0kg N ha^{-1}
T_2	0 ton ha^{-1} Rice husk biochar + 30kg N ha^{-1}
T_3	0 ton ha^{-1} Rice husk biochar + 60kg N ha^{-1}
T_4	0 ton ha^{-1} Rice husk biochar + 90kg N ha^{-1}
T_5	2 ton ha^{-1} Rice husk biochar + 0kg N ha^{-1}
T_6	2 ton ha^{-1} Rice husk biochar + 30kg N ha^{-1}
T_7	2 ton ha^{-1} Rice husk biochar + 6kg N ha^{-1}
T_8	2 ton ha^{-1} Rice husk biochar + 90kg N ha^{-1}
T_9	4 ton ha^{-1} Rice husk biochar + 0kg N ha^{-1}
T_{10}	4 ton ha^{-1} Rice husk biochar + 30kg N ha^{-1}
T_{11}	4 ton ha^{-1} Rice husk biochar + 60kg N ha^{-1}
T_{12}	4 ton ha^{-1} Rice husk biochar + 90kg N ha^{-1}

Soil sampling and analysis

Initial soil samples were collected from thirty-six (36) plots at a depth of 0–15 cm with a soil auger. The samples were bulked together to form a composite sample. The soil samples collected were air-dried, gently crushed and passed through a 2-mm sieve and taken to the laboratory for physical and chemical analyses. Soil pH was measured in a 1:1 soil to water ratio (McLean, 1983). The Walkey and Black procedure was used to determine soil organic content (Walkey

and Black, 1934). The nitrogen content was determined using the Kjeldahl digestion and distillation procedure. The cation exchange capacity was determined by the NH_4OAc method. Calcium and magnesium (Mg) were determined by atomic absorption spectrophotometry while potassium (K) and sodium (Na) were determined by flame photometry.

Characteristics of the biochar

The biochar chemical analysis results presented in Table 3 show that biochar prepared from rice husk that was cultivated in slightly acidic soil also had slightly acidic properties at pH 6.5. The biochar had lower concentrations of Ca, Mg, and Na, however a higher content of ash and organic carbon. The pyrolysis of rice husk increases organic carbon in the materials. Rice husk biochar had ECEC of 13.67 m kg^{-1}.

Table 3. The chemical composition of rice husk biochar.

Parameters	values
pH (1:1H_2O)	6.5
OC (%)	43.5
Ash (%)	58.2
N (%)	0.62
P (mg kg^{-1})	0.57
K (mg kg^{-1})	0.48
ECEC (mg kg^{-1})	13.67
Ca (mg kg^{-1})	2.34
Mg (mg kg^{-1})	0.89
Na (mg kg^{-1})	0.23
Al (mg kg^{-1})	3.4
Fe (mg kg^{-1})	1.2

Data collection

The data were collected every 2 weeks starting from 2 WAP and terminated at 10 WAP. Randomly, 5 maize plants were selected from individual sub-plots and labelled for measurements. Parameters assessed were the plant height measured from the base of the stem to the last leaf using a graduated ruler, number of leaves was determined by counting the leaves on plant and plant girth was measured at the soil level using a slide calliper.

Data analysis

Effects of different treatments were analysed by analysis of variance. The least significant difference (LSD) test was applied to distinguish the treatment differences ($p<0.05$) using the statistical software GenStat 18th edition.

Results and Discussion

Plant height

There was a general increase in plant height starting from 2 WAP to the end of the experiment (8 WAP) for all the treatment levels (Table 4). Mean differences in height among treatments were significant ($p<0.05$) at the end of the experiment. The highest mean plant height (32.34 cm) was recorded at T_{12} whilst the lowest mean plant height (10.74 cm) was recorded at T_1. Similar trends were observed at 4, 6 and 8 WAP where mean plant height of maize was significantly higher with the combination of rice husk biochar and inorganic nitrogen fertilizer. The highest mean heights were observed at T_{12}, T_{11}, T_{10}, T_9, T_8, T_7, T_6, T_5 from 2 WAP to the end of the experiment at 8 WAP (Table 4).

Table 4. The influence of integrated soil fertility management on maize plant height (cm).

Treatment	Week after planting (WAP)			
	2 WAP	4 WAP	6 WAP	8 WAP
T_1	10.74a	29.24bc	89.14bn	98.82dq
T_2	11.56c	34.46e	93.83abc	104.93bnr
T_3	13.43d	38.45v	97.43vn	112.45xv
T_4	16.34z	42.33g	100.45k	118.54mb
T_5	14.55q	49.56j	114.65qa	128.45aa
T_6	18.34r	56.04b	129.54tr	133.45cf
T_7	22.43t	61.25v	141.56hi	179.34fj
T_8	28.93s	68.09w	156.83f	189.95pp
T_9	18.45p	65.45t	137.54er	165.76sw
T_{10}	24.45x	69.53k	143.43am	193.45ah
T_{11}	26.59y	73.66s	168.44cff	204.56qw
T_{12}	32.34h	82.78u	174.76gh	220.45xyz
CV%	5.4	9.4	5.6	8.3

Means with the different letter(s) in a column are significantly different at the 5% level of probability.

The significant increase in the plant height of maize could be ascribed to the fact that the added rice husk biochar (58.2%) increased the supply and availability of plant nutrients in the soil. This approves the recommendation that higher accessibility of nutrients increases the vegetative growth of plants (Zoghi et al., 2019).

Plant girth

The effect of rice husk biochar on maize girth at different weeks after planting is described in Table 5. It was clear that rice husk biochar and inorganic nitrogen

fertilizer had a significant effect on the plant girth. At 2 WAP, the highest plant girth was recorded in the treatment T_{12} while the lowest was recorded at T_1. This trend was, however, similar in all phases.

Table 5. The influence of integrated soil fertility management on maize plant girth (cm).

Treatment	Week after planting (WAP)			
	2 WAP	4 WAP	6 WAP	8 WAP
T_1	0.58bd	0.83ee	2.01c	4.12qw
T_2	0.67as	1.01ab	2.46bv	4.64pk
T_3	0.75ss	1.12cv	2.74vv	4.96mn
T_4	0.88cv	1.21yy	2.91qw	5.33mb
T_5	1.08bv	1.45qq	3.25rt	6.34max
T_6	1.16ng	1.71hi	3.54uh	6.89nv
T_7	1.24qw	1.98pt	3.85ky	7.16xzy
T_8	1.38bb	2.05yg	4.12gg	7.44cj
T_9	1.49rr	2.18jk	4.53py	7.98kt
T_{10}	1.61jj	2.29mm	4.94hh	8.33ree
T_{11}	1.84hn	2.41am	5.25xz	8.76ytr
T_{12}	2.04kk	2.78mx	5.98zv	8.99ghf
CV%	5.4	1.4	2.7	6.7

Means with the different letter(s) in a column are significantly different at the 5% level of probability.

It is clear that there is a noticeable difference in plant girth with the highest rate of rice husk biochar treatments compared to 0 ton ha^{-1} biochar treatments. A comparable result was found by Varela et al. (2013) who stated that an increase in the application of both wood and rice husk biochar improved the stem size of *Ipomoea aquatica*. They, furthermore, stated that the decomposition of wood and rice husk biochar improved the organic matter content in the soil leading to increase in water holding capacity of soil, thus improving stem diameter.

The number of leaves

Observations made on the number of leaves produced by *Zea mays* showed an increase from week 2 to week 8 (Table 6). By week 2, mean differences among treatments had already been significant ($p<0.05$), with T_{12}, T_{11}, T_{10}, T_9, T_8, T_7, T_6 and T_5 producing more leaves relative to the treatments in T_1 (Table 6). These differences were still significant ($p<0.05$) by the end of the experiment. Similar trends were, however, observed from 4 WAP to the end of the experiment at 8 WAP.

Plants that received the highest rate of rice husk biochar and inorganic nitrogen fertilizer recorded a greater number of leaves than T_1. The application of

biochar improved the fertility of the soil and safeguarded the availability of vital nutrients that boosted the vegetative growth of maize. Our findings corroborate with the findings of Ali et al. (2017).

Table 6. The influence of integrated soil fertility management on the number of leaves of maize.

Treatment	Week after planting (WAP)			
	2 WAP	4 WAP	6 WAP	8 WAP
T_1	4.01a	7.43gh	9.44cdd	10.12yu
T_2	4.15ab	7.46gh	9.68yt	10.27got
T_3	4.16ab	7.49gh	9.67yt	10.65ye
T_4	4.33dc	7.50gh	10.02aa	10.95qa
T_5	5.49cc	8.77kb	10.58ba	11.23ax
T_6	5.78vc	8.84kb	10.89cgd	11.30ax
T_7	5.76vc	8.93kb	11.23q	11.89ws
T_8	5.87dd	8.99kb	11.56we	12.32pz
T_9	6.56ff	10.83vy	11.89rt	13.00nn
T_{10}	6.57ff	11.02bb	12.34pq	13.56ww
T_{11}	6.75wr	11.48hi	12.75mn	13.86uy
T_{12}	6.95qs	11.93xy	12.92am	14.03zx
CV%	0.8	1.6	5.6	5.2

Means with the different letter(s) in a column are significantly different at the 5% level of probability.

Conclusion

The highest vegetative growth parameters were obtained at 4 ton/ha of biochar and inorganic nitrogen fertilizer which were effective at 90 kg N ha^{-1} and 60 kg N ha^{-1}. It was, therefore, concluded that the combination of various sources of inorganic and organic nutrients improved the performance of growth parameters of *Zea mays* rather than the sole use of either the inorganic fertilizers or the organic sources.

References

Ali, K., Arif, M., Shah, F., Shehzad, A., Munsif, F., Mian, I.A., & Mian, A.A. (2017). Improvement in maize (*Zea mays L*) growth and quality through integrated use of biochar. *Pakistan Journal of Botany, 49* (1), 85-94.

Dume, B., Berecha, G., & Tulu, S. (2015). Characterization of biochar produced at different temperatures and its effect on acidic Nitosol of Jimma, Southwest Ethiopia. *International Journal of Soil Science, 10* (2), 63-73.

Gul, S., Whalen, J.K., Thomas, B.W., Sachdeva, V., & Deng, H. (2015). Physico-chemical properties and microbial responses in biochar-amended soils: Mechanisms and future directions. *Agriculture Ecosystems and Environment, 206*, 46-59.

Jindo, K., Mizumoto, H., Sawada, Y., Monedero, M.A.S., & Sonoki, T. (2014). Physical and chemical characterization of biochars derived from different agricultural residues. *Biogeosciences, 11*, 6613-6621.

McLean, E.O. (1983). Soil pH and lime requirement. *Methods of soil analysis: Part 2 Chemical and microbiological properties, 9*, 199-224.

Munongo, M.E., Nkeng, G.E., & Njukeng, J.N. (2017). Production and characterization of compost manure and biochar from cocoa pod husks. *International Journal of Advanced Scientific Research, 2* (2), 26-31.

Prabha, B., Pugalendhi, S., & Subramanian, P. (2015). Design and development of semi-indirect non-electric pyrolytic reactor for biochar production from farm waste. *Indian Journal of Agriculture Science, 85* (4), 85-591.

Ragasa, C., Chapoto, A., & Kolavalli, S. (2014). *Maize productivity in Ghana (Vol. 5).* International Food Policy Research Institute.

SARI (2016). Savanna Agricultural Research Institute. Agro-meteorological Unit Nyankpala Tamale Ghana, 27.

Sohi, S., Krull, E., Capel, E.L., & Bol, R. (2010). A review of biochar and its use and function in soil. *Advances in Agronomy, 105* (1), 47-82.

Sheahan, M., & Barrett, C.B. (2014). *Understanding the agricultural input landscape in sub-Saharan Africa: Recent plot, household, and community-level evidence.* The World Bank.

Vanlauwe, B., Descheemaeker, K., Giller, K.E., Huising, J., Merckx, R., Nziguheba, G., & Zingore, S. (2015). Integrated soil fertility management in sub-Saharan Africa: unravelling local adaptation. *Soil, 1* (1), 491-50.

Varela, M., Rivera, O., Huang, O.E.B., Chien, W.J., & Wang, Y.M. (2013). Agronomic properties and characterization of rice husk and wood biochars and their effect on the growth of water spinach in a field test. *Journal of Soil Science and Plant Nutrition, 13* (2), 51-266.

Venkatesh, G., Srinivasa, R.C.H., Gopinath, K.A., & Sammi, R.K. (2015). Low-cost portable kiln for biochar production from on-farm crop residue. *Indian farming, 64* (12), 9-12.

Walkey, A., & Black, A. (1934). An experiment of the Degtjareff methods for determining soil organic matter and a proposed modification of the chronic and acid titration method. *Soil Science, 37*, 29-38.

Xu, T., Lou, L., Cao, R., Duan, D., & Chen, Y. (2012). Effect of bamboo biochar on pentachlorophenol leachability and bioavailability in agricultural soil. *Science of the Total Environment, 414*, 727-731

Yu, L., Jie, J.Y., Rong, Z.X., Tong, L.G., Xin, Z.L., & Bo, M.H. (2014). Improvement to maize growth caused by biochars derived from six feed stocks prepared at three different temperatures. *Journal of Integrative Agriculture, 13* (3), 533-540.

Zoghi, Z., Hosseini, S.M., Kouchaksaraei, M.T., Kooch, Y., & Guidi, L. (2019). The effect of biochar amendment on the growth, morphology and physiology of *Quercus alnifolia* seedlings under water-deficit stress. *European Journal of Forest Research, 138*, 967-979.

UTICAJ INTEGRISANOG UPRAVLJANJA PLODNOŠĆU ZEMLJIŠTA NA PARAMETRE VEGETATIVNOG RASTA *ZEA MAYS* U EKOZONI GVINEJSKE SAVANE U GANI

Abukari Ammal[1*], Akwasi Adutwum Abunyewa[2] i Edward Yeboah[3]

[1]Odsek za šumarstvo i upravljanje šumskim resursima, Fakultet za prirodne resurse i životnu sredinu, Univerzitet za razvojne studije, Tamale, Gana
[2]Odsek za agrošumarstvo, Koledž za poljoprivredu i prirodne resurse, Univerzitet za nauku i tehnologiju Kwame Nkrumah, Kumasi, Gana
[3]Savet za naučno i industrijsko istraživanje – Institut za ispitivanje zemljišta Kwadaso, Kumasi, Gana

R e z i m e

Širom sveta, skrenuta je pažnja na upotrebu ekološki prihvatljive primene biouglja kako bi se poboljšala produktivnost useva. U Gani postoje dostupne potencijalne sirovine koje ostaju neiskorišćene i mogu se upotrebiti za proizvodnju biouglja. Ovom studijom se stoga istražuje uticaj različitih količina biouglja od pirinčane ljuske i različitih količina neorganskog azota (N) na rast *Zea mays* u gradu Nyankpala, u severnoj Gani. Poljski ekperimenti su sprovedeni za period uzgajanja useva 2012. godine. Tretmani su uključivali 4 različite količine mineralnog azotnog đubriva (0 kg N ha^{-1}, 30 kg N ha^{-1}, 60 kg N ha^{-1} i 90 kg N ha^{-1}) i 3 različite količine biouglja od pirinčane ljuske (0 t ha^{-1}, 2 t ha^{-1} i 4 t ha^{-1}). Tretmani su bili raspoređeni u dizajnu podeljenih parcela sa tri ponovljanja. Ocenjivani vegetativni parametri uključivali su broj listova, visinu biljke i obim biljke. Tretmani su pokazali značajan (p<0,05) uticaj na sve razmatrane osobine. Kombinovani uticaji mineralnog azotnog đubriva i biouglja od pirinčane ljuske značajno su uticali na parametre vegetativnog rasta *Zea mays* sa maksimalnim vrednostima zabeleženim pri upotrebi 4 t ha^{-1} biouglja od pirinčanih ljuski. Ipak, ovo zapažanje odgovara količini od 2 t ha^{-1} biouglja od pirinčanih ljuski čijom su upotrebom zabeleženi optimalni parametri rasta u poređenju sa kontrolom. U granicama ovog rada, zaključeno je da se parametri rasta *Zea mays* u ekozoni gvinejske savane u Gani mogu značajno poboljšati primenom 4 t ha^{-1} biouglja od pirinčane ljuske. Trenutno je neophodno integrisano upravljanje plodnošću zemljišta, razumna kombinacija mineralnih đubriva i ostataka iz različitih izvora za održavanje životne sredine. Eksperiment je pokazao da primena biouglja od pirinčanih ljuski može poboljšati parametre rasta *Zea mays*. Ipak, potrebno je da se urade dodatni

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[*]Autor za kontakt: e-mail: aammal@uds.edu.gh

eksperimenti korišćenjem većih količina biouglja od pirinčane ljuske kako bi se osigurala odgovarajuća količina primene.