Research article

Physicochemicals Properties of Soils with Peanut Shell Amendment and Its Impact to Growth and Yield of Maize

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Abstract The present research studied how the addition of peanut shell to the soil effected on physicochemical properties of soil and plant growth. Waste peanut shells were used to enhance soil properties by composting for cultivation of plants as the organic fertilizer. In the composting step, 2:3 (v/v) of peanut shell and soil was mixed for two months and utilized for the cultivation of maize plants. Some parameters of soil, peanut shell and peanut shell-compost such as pH, moisture, nitrogen, phosphorus, potassium, organic carbon, total sulphur, calcium and magnesium were examined by using their respective standard methods to compare the properties of control and compost-soil. It is observed that the soil added with peanut shell-compost has a potential increasement of nitrogen, phosphorous, potassium, total sulphur, total calcium and total magnesium in plant growth media than control soil. The results obtained in plant growth media also pointed out that the growth rate and yield percent with composed soil were better than those of control soil. These research findings can contribute to the local people from agricultural field with the scientific information of waste peanut shell as low cost alternative fertilizer.

Keywords physicochemical properties, soil, peanut shell, peanut shell fertilizer

INTRODUCTION

Soil quality is the capacity of a soil to a function and this function balances the physical, biological, and chemical components of soil (Karlen et al., 1997). Soil physical properties can give a profound effect on how soils influence soil quality and productivity. Soil quality level is improved by soil physical properties that measure nutrient and moisture present in soils. The physical properties of soil contain soil texture, bulk density, water holding capacity, organic matter content, soil structure, soil color, and soil consistence (Schoeneberger et al., 2012). By adding organic compost to soil before planting gives the soil the boost in nutrients plants depend upon to grow. Fertilizers added later help provide the plants to use nutrients well. Various organic fertilizers amend the soil, including manure, blood meal and wood ash. Among organic materials, peanut shell also has few beneficial minerals plants can absorb and are best use as a protective covering. The beneficial effects on crop production are found and soil properties are directly related to the physical, chemical and biological properties of the composts used (He et al., 1995). Application of organic manures (sewage sludge, compost, manure) in a heavy soil aggregation support porosity, permeability, and air and also in sandy soil to hold water and nutrients help (Abusharer, 1996).

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OBJECTIVE

This study focused on the changes in the chemical properties of soil prepared by applying during aerobic decomposition and the plant growth.

METHODOLOGY

Sample Collection

Surface soil samples were collected from farmland of Changgyi Village, Tha- beik- kyin Township, Mandalay region in Myanmar. Peanut shells were collected from peanut shell factory, Mandalay Industrial Zone and they were crushed into small pieces and used as the organic fertilizer for maize plants.

Preparation of Peanut Shell Fertilizer

The combined ratio of peanut shell and soil 2:3 v/v were mixed. The composting process was initialized by preparation of the compost container with suitable size of plastic basket making five small holes in the bottom. During composting process, combined sample was turned periodically for better aeration. After composting 2 months, soil color was found as dark color because of the decomposition of waste materials into the soil.

Determination of Soil Texture

Soil samples (before and after plantation) of texture were analyzed at Department of Agriculture (land use) of Yangon, Myanmar by pipette method (AOAC International, 1999).

Determination of Physicochemical Properties of Three Samples

Determination of pH:
A mixture of air-dried sample and water (1:5) was placed in a 50 mL shaking bottle and shaken vigorously for 5 minutes. The pH of soil suspension was measured with a pH meter (F-51, HORIBA).

Determination of moisture:
The sample was allowed to dry in an electric oven at 105°C, cooled in desiccators and weighed. It was repeated until the constant weight was obtained. From the loss in weight, the percentage of moisture in the sample is calculated (AOAC International, 1999).

Determination of total nitrogen:
The sample at 0.5 g was put in 600 mL digestion tube and added 1 g of catalyst and then it is gently heated until frothing ceases. The flask was removed from the heater and cooled, added distilled water and transferred to the suitable volumetric flask. Accurately 20-25 mL of 2% boric acid was placed in and methyl the receiving conical flask red indicator (2-3) drops was added. Enough water was added to cover the end of the condenser outlet tube. 5 mL of aliquot was pipetted into the distillation tube and 25 mL of 40% NaOH was added and was distilled for about 4 minutes. The receiving flask was removed and the outlet tube was rinsed into the receiving flask with a small amount of distilled water. The ammonia distillate was titrated with excess acid 0.02 N H_2SO_4. The blank was determined in the same manner (AOAC International, 1999).

Determination of total phosphorous:
Aliquot (5-25 mL) depending on phosphorus content was pipetted in a 50 mL volumetric flask and added 5 mL of Barton's Reagent and diluted to 50 mL with distilled water. After 1hour, it was measured with spectrophotometer at 420 nm (AOAC International, 1999).

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Determination of available phosphorous:
Air-dried sample at 2 g was weighed and placed in a 500 mL shaking bottle. A 400 mL of buffer solution was poured into the flask and the contents were shaken for 30 minutes. And then it was filtered and 50 mL of extract was pipetted into a 100 mL volumetric flask. Three drops of saturated 2,4 dinitrophenol, 4 mL of 2.5% sulphomolybdic acid solution and 6 drops of freshly prepared chlorostannous acid reductant were added to the solution. The solution was made up to 100 mL with distilled water. The amount of P_2O_5 was determined spectrophotometrically at 660 nm and calibration curve set up employing the standard solution was used to determine to P_2O_5 in the soil (AOAC International, 1999).

Determination of total potassium:
The sample (5 g) was heated in a pre-weighed porcelain crucible by heating slowly without combustion. Then the crucible was placed in the furnace at 550°C for 16 h till a white ash of constant weight was obtained. The ash (0.1 g) was digested for 5 minutes with 2 mL of concentrated hydrochloric acid in a beaker. Then, it was dissolved in 16 mL of 25% hydrochloric acid solution by warming on a water bath for a few minutes. Then it was transferred to a 100 mL volumetric flask and the volume to the mark with distillated water (AOAC International, 1999).

Determination of available potassium:
Air-dried sample at 5 g was placed in a 100 mL shaking bottle containing 50 mL of 1 M ammonium acetate solution. It was shaken for 1 h and filtered. Available K_2O was determined on the filtrate by using a flame photometer (AOAC International, 1999).

Determination of organic matter:
The sample was ash at 500-600°C by placing a suitable weight (0.5-1.0 g) of the sample in a silica crucible and heating it in a muffle furnace for 4-6 h. Loss of weigh on ignition can be used as a direct measure of the Organic Matter (MO) (AOAC International, 1999).

Determination of total sulphur:
Aliquot (2-5 mL) was taken in 50 mL volumetric flask. Acetic acid 50% (5 mL), Gum acacia 0.25% (2 mL) and (1 mL) of orthophosphoric acid were added into this flask and then was shaken for 1 minute. The volume was made up to 50 mL with distillated water and measured the turbidity at 440 nm (AOAC International, 1999).

Determination of total calcium and magnesium:
The stock standards in concentration of 1000 ppm is prepared from pure metal wire, granules, foil, metal oxide or other suitable primary standard compounds of the elements. A calibration curve was applying by recording the absorbance of a series of working standards. The calibration must be done for each set of analysis. Aliquot is taken depending on concentration in a 50 mL volumetric flask and added 5 mL of strontium chloride and dilute 50 mL with distilled water. The content of element is determined from the standard curve (AOAC International, 1999).

Plantation of Maize on Soil Samples

The peanut shells were used as natural-based biofertilizer in the plantation of maize. The maize grains were sowed into the soil that placed in the plastic bags and these bags were regularly watered. After 7 days, the germination of maize grains occurred. Then the high of the nursery plants were about 2 to 2½ inches, they were picked out and transferred to specially prepared roles for plantation experiment. Each same size 10 plants were cultivated in soil without treatment as control and treatment with the peanut shell. A row has 10 ft length and 1 ft width. Comparison of the maize plants in the control soil and treated soil were done after one month, two months, three months and four months and they were shown in Fig. 1 and the height of maize plants were determined.

Determination of Maize Height and Yield

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The height of plant were measured at the end of four months, the time of harvest and the yield percent was determined based upon the total weight of maize samples.

After one month (control) | After one month (treatment) | After two month (control) | After two month (treatment)

After three month (control) | After three month (treatment) | After four month (control) | After four month (treatment)

Fig. 1 Comparison of the maize growth in the untreated and treated soil

RESULTS AND DISCUSSION

Soil Texture Before and After Treatment

The texture contents of soil samples before and after treatment were measured and the results obtained shown in Table 1.

Table 1 Soil texture before and after treatment

Sample	Texture				Remark
	Sand (%)	Silt (%)	Clay (%)	Total	
Before treatment	76.76	9.36	13.88	100.00	Sandy loam
After treatment	70.76	18.36	10.88	100.00	Sandy loam

According to Table 1, while the soil before treatment contains sand 76.76%, silt 9.36% and clay 13.88%, the soil after treatment possesses sand 70.76%, silt 18.36 and clay 10.88% and therefore these two soils lie in the sandy loam texture. Double amount of silt percent in treated soil sample inform that it is more suitable for plant crop.

Some Physicochemical Properties of Untreated Soil, Treated Soil and Peanut Shell

From the experimental results, pH, moisture, organic matter, nitrogen, phosphorous, potassium, sulphur, calcium and magnesium of samples were listed in Table 2.

According to the results, the values pH in peanut shell (6.62), soil sample (6.49) and peanut shell fertilizer (6.75) were found to be consistent with the recommended pH level of soil according to the National Gardening Association, i.e., pH values between 5.8 and 6.8 (Thermo Fisher Scientific, 2013). Chemical constituents of peanut shell told the reason of higher level of soil nitrogen, phosphorous, potassium and organic carbon after composting due to the acceptance of

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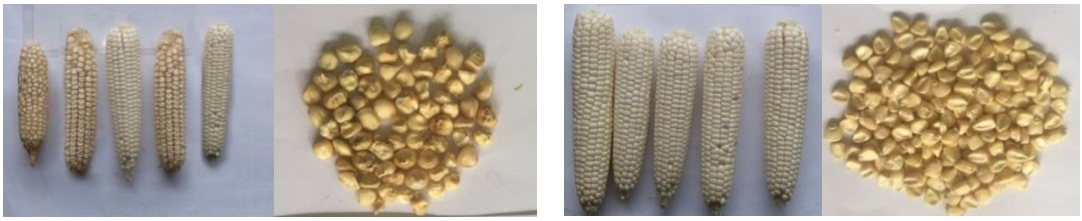
nutrients released from the peanut shells. Nitrogen content increased with the amount of peanut shell composed applied, which is due to high the increased amount of nitrogen was found in the treated soil by applying compost which include nitrogen abundant peanut shell. Moreover similar effects were resulted as better responses in total sulphur (640.5 mg/kg), total calcium (1.44%) and total magnesium (1.51%) contents in the treated soil sample than the untreated one.

Table 2 Physicochemical properties of three tested samples

Parameter	Unit	Samples		
		Untreated soil sample	Treated soil sample	Peanut shell
pH	-	6.49	6.75	6.62
Moisture	%	4.29	5.87	10.98
Total nitrogen	%	0.14	1.16	1.26
Total Phosphorous	%	0.87	0.67	1.57
Available Phosphorous	%	0.25	0.43	0.01
Total Potassium	%	0.59	1.48	0.78
Available Potassium	%	3.07	3.66	3.00
Organic carbon	%	20.67	39.01	30.00
Total sulphur	mg/kg	605.0	640.5	140.0
Total calcium	%	0.91	1.44	0.27
Total magnesium	%	1.35	1.51	0.32

The Effect of Natural Fertilizer on the Maize Growth

The effect of natural fertilizer on the maize growth was determined by applying two indicators, plant height and maize yield and the results obtained were shown Fig. 2.



Maize grains from untreated soil **Maize grains from treated soil**

Fig. 2 Comparison of the yield of maize grains

Table 3 Comparative effect of untreated and treated soil on plant height and maize yield

	Untreated soil	Peanut shell compost
Plant height	150 cm	165 cm
Maize yield (No of maize/plant)	38 %	45 %

As shown in the Table 3, the plant height and yield of maize grain were measured at the end of four months and Compost organic materials led to better qualities to the soil as compared with the soil without compost. These results are in accordance with the literature values (Badar et al., 2015). And then the soil prepared with peanut shell also render slightly better growth rate of plant height (165 cm) than that of untreated soil (150 cm).

CONCLUSION

Peanut shell-compost led to increased amount of physicochemical properties of soil, improvement in plant growth and yield. According to the research studies, the peanut shell-compost had potential

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effect on soil especially for the enhancement of essential nutrients. It seems that peanut shell cellulose tissue can create the suitable size of nourishing compost particles and high porosity and these facts can provide high maize yield. The results obtained showed that providing peanut shell-compost as natural fertilizer was an appropriate method to enhance the plant nutrients and growth. It is consistent with environmental standard and recommendation that peanut shell-compost is suitable in the plant growth media and can be applied as a recycled material in the agriculture.

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REFERENCES

Abusharer, T.M. 1996. Modification of hydraulic properties of a semiarid soil in relation to seasonal application of sewage sludge and electrolyte producing compounds. Soil Technology, 9, 1-13.

AOAC. 2005. Official Methods of Analysis. 18th edn, Association of Official Analytical Chemists, Arlington, VA., USA.

Badar R., Khan M., Batool B. and Shabbir S. 2015. Effects of organic amendments in comparison with chemical fertilizer on cowpea growth. International Journal of Applied Research, 1 (5), 66-71.

He, X.T., Logan, T. and Traina, S.J. 1995. Physical and chemical characteristics of selected municipal solid waste composts. Journal Environmental Quality, 24, 543-552.

Karlen, D.L., Mausbach, M.J., Doran, J.W., Cline, R.G., Harris, R.F. and Schuman, G.E. 1997. Soil quality: A concept, definition, and framework for evaluation (A Guest Editorial). Soil Science Society of America Journal, 61, 4-10.

Sanchez-Monedero, M., Roig, A., Cegarra, J., Bernal, M.P., Noguera, P. and Abad, M. 2004. Composts as media constituents for vegetable transplant production. Compost Science utilization, 12, 161-168.

Schoeneberger, P.J., Wysocki, D.A., Benham, E.C. and Soil Survey Staff. 2012. Field book for describing and sampling soils. Version 3.0, Natural Resources Conservation Service, National Soil Survey Center, SSSA, USA.

Thermo Fisher Scientific (n.d.). 2013. Gardening & soil pH. Retrived from ww.eutechinst.com/tips/ph/15-soil-ph.pdf

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