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Effects of soil amendments on aggregate stability and selected agronomic parameters of pepper (*Capsicum annuum*)

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Abstract

Soil amendment had been used to ameliorate soils for better productivities with improved aggregate stability, thus, a research was conducted to determine the effects of poultry manure, portland cement and combined poultry manure plus portland cement amended soil on time (s), kinetic energy (J m^{-2} hr^{-1}) of simulated rainfall to disintegrate soil aggregate and selected agronomic parameters (number of leaves, plant height, leaf area, number of roots, stem girth, root girth, and root length) of pepper (*Capsicum annuum*) in the Greenhouse; Teaching and Research Farm of The Oke – Ogun Polytechnic, Saki, Oyo State, Nigeria, in a complete randomized design. The treatments were four and replicated three times. Results indicated that, all treatments had increased significant ($P \leq 0.05$) effects on the aggregate stability, also both poultry manure and combined poultry manure plus portland cement had significant ($P \leq 0.05$) improvements on all the seven agronomic parameters, while portland cement only had significant ($P \leq 0.05$) increment on five agronomic parameters and no significant ($P = 0.05$) effects was observed on stem girth and root length. Poultry manure, portland cement and combined poultry manure plus Portland cement had pronounced distinct statistical significant ($P \leq 0.05$) improvement on the three, four and five selected agronomic parameters respectively, however, based on the strength of analysis of variance, cost and LSD, combined poultry manure plus Portland cement at 10:10 gm could be recommended for the improvements of soil aggregate stability and growth of pepper (*Capsicum annuum*) in a derived savannah with sandy soil.

Key-words: Vegetable, Tropics, Soil Fertility, Soil Conditioner, Kinetic Energy

Introduction

Pepper (*Capsicum annuum*) known 'Tatase' in Yoruba language (South west, Nigeria) is a very important fruit vegetable in the tropics, belongs to family Solanaceae and it is ranked as the world second most important vegetable after tomatoes (Olaniyi and Ojetayo, 2010). Sweet pepper, bell pepper, cherry pepper and green pepper are the popular species of *C. annuum* (Messraen, 1992). The fruits are non-pungent and have been widely used in immature or green stage as vegetable for stuffing or for salads. Pepper fruits are a rich source of vitamin C, polyphenols, chlorophylls, carotenoids, sugars, magnesium, calcium, potassium, phosphorus and iron (Flores et al., 2009; Jadczak et al., 2010). Pepper is a valuable crop species of the world. In Nigeria and other parts of the humid and semi-arid tropics it is one of the most important vegetables grown (Aliyu, 2000). It

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is commonly used as condiments (Alabi, 2006) and the non-pungent species (*C. annuum*) are eaten raw as salads. Pepper can be grown in the tropics preferably with a rainfall of 600 - 1200mm, temperature of about 18 – 27 ^{o}C and a sandy loam soil which holds moisture fairly with a liberal supply of organic matter is ideal for the growth of pepper (Udoh et al., 2005).

Conservation of soil fertility is thus essential for sustainable crop production and increase in yield while soil amendment including calcium derivatives and organic manuring has been reported to play a vital role in this regard (Jablonska 1990; Ullah et al., 2008). Carbon content, water holding capacity, aggregation of the soil and a decrease in soil bulk density are some of the soil properties enhanced by poultry manure (Weil and Kroontje, 1979). Organic materials especially cow dung poultry droppings, refuse compost, farm yard manure and bio-humus are suitable for increasing crop production particularly among subsistence farmers in West Africa (Amadi and Ile Bari, 1992; Amadi et al., 1993; Obire and Akinde, 2004; Adegunloye et al., 2007).

Cement has been a good material in aggregate stability; however, research on cement amendment to soils for plant growth was not readily available, other than its pollution effects which were not the same with actual incorporation of the material, high in calcium into the soil to release its nutritional content for plant development (Adamson et al., 1994; Mandre, 1997; Mandre et al., 1998).

Soil conditioners / amendments have been used in agriculture to stabilize soil structure, effective in increasing hydraulic conductivity and porosity, improving the water holding capacity, maintaining high water infiltration; to prevent soil loss through erosion processes, improve soil fertility at the same time increased crop yield, and such soil conditioners includes: polysaccharides, starch copolymers and numerous synthetic materials including various formulations of copolymers of hydrolysed polyacrylonitrile, vinyl acetate maleic acid, polyvinyl alcohol (PVA), polyacrylamide (Azam, 1980; De Boodt, 1993; Shanmuganathan and Oades, 1982).

The total kinetic energy of rainfall (KE) is used as an indicator of the potential ability of rain to disrupt soil aggregates and it essentially represents the sum of kinetic energy of the rain drops falling on the ground (Salles et al. 2002; Van Dijk, 2002). According to Fornise (2005), the kinetic energy of rainfall may be expressed in two ways: as time-specific kinetic energy and volume-specific kinetic energy. Time-specific kinetic energy is calculated per unit area per unit time KEtime (J $m^{-2}hr^{-1}$) while the volume-specific kinetic energy of rain is expressed as the rainfall depth per unit area KEmm (J $m^{-2}mm^{-1}$).

The cost of cement should not be an obstacle in ameliorating problematic soils and to stabilize soil aggregate for better soil productivities, thus, it could therefore be hypnotized that poultry manure and Portland cement have effects on soil physical and chemical property of the soil and the objectives of this study were to determine the effects of varying proportion of poultry manure, portland cement and combined poultry manure plus portland cement on soil aggregate stability and selected agronomic characteristics of pepper (*Capsicum annuum* (L.).

Materials and Methods

Location

The study was carried out at the Greenhouse, Teaching and Research Farm of the Soil Science and Agricultural Technology Department of the Oke - Ogun Polytechnic Saki, located within latitude 8.33˚ and longitude 2.40˚ in the derived savannah zone; South western Nigeria. The experiment was carried out in 36 uniform bowl filled with 1.5 kg of soil that has passed through 2 mm sieve to mimic the situation on the field. The experiment took place between 11 October and 06 December 2019. The pattern of rainfall is bimodal with average annual rainfall estimated to be about 1200 mm (The Oke-Ogun Polytechnic Watch Dog weather station, 2019). The average temperature of the greenhouse was 28 ^{0}C. The particle size distribution was carried out using the hydrometer method described by Bouyoucos (1962) as presented by (Gee and Or, 2002) using 0.2 M sodium hydroxide as dispersing agent. Soil pH was determined with a glass electrode pH meter in both distilled water using 1:1, soil: water and 0.1 M KCl (using 1:1 soils: KCl solution) as described by Thomas (1996), organic carbon was determined by

the chromic acid digestion method (Walkley and Black, 1935). The total nitrogen concentration was determined by macro-Kjeldahl method (Bremner, 1996), and the available P was extracted by Bray - 1 method (Kuo, 1996) and determined using spectrometer. Exchangeable K, Ca, Na, and Mg were extracted with neutral (pH 7) solution of 1N NH_4OAc, K and Na were determined using the flame photometer and Mg and Ca by the atomic absorption spectrophotometer. The cement and poultry manure used was subjected to chemical analysis.

Soil and treatment preparation

The soil used for this experiment was sampled at the Teaching and Research Farm of the Department of Soil Science and Agricultural Technology, The Oke - Ogun Polytechnic. With the aid of spade, the soil was sampled at 0-15cm depth, bagged and spread for air – drying in the soil laboratory for 48 hours (2 days), after 48 hours the soil was sieved with 2 mm mesh and 1.5kg soil was weighed into the experimental pots / bowls. Also part of the sieved soil was taken to laboratory for chemical analysis. Poultry manure was obtained from the Research Farm of the Department of Animal Production and Health, The Oke - Ogun Polytechnic, Saki (TOPS) and was treated accordingly, before it was used. The portland cement was bought from a cement shop in Saki.

Greenhouse experiment

Sufficient quantity of poultry manure was oven dried at 60 ^{0}C and finely ground to pass a 0.4 mm sieve and stored in plastic containers until use. The soil samples weighed (1.5 kg) into plastic planting bowls. The experiment involved four (4) levels of treatment in a complete randomized design (CRD) of 12 plots and replicated three times. Quantities (0, 10, 20, 30 gm and ratios 0: 0, 5: 5, 10: 10 and 15: 15 gm) of portland cement and poultry manure were mixed with the soil sample, the soil, portland cement and poultry manure were thoroughly mixed and moistened to 80 % field capacity. Planting of pepper seeds were carried out fourteen (14) days after incorporation of the treatments. Three (3) seeds were planted per bowl. The bowls were watered at an interval of 2 days, up to about their field capacity throughout the period of the experiment. Weeding was done by hand picking. Agronomic parameters of pepper were measured from the plots; plant height (cm), stem girth (cm), number of leaves and leaf area (cm^2), root length, root girth and numbers of root at the end of the experiment (8 weeks). The taller plant from each plot was selected for plant height measurement which was measured from the soil level to tip of the plant with a meter rule, also the root length with meter rule. The number of leaves and number of roots were simply counted, while the stem girth and root girth were measured with venire caliper. Determination of leaf area Index (LA1) was done as described by (Watson et al., 2006).

Evaluation of aggregate stability by time and kinetic energy of artificial rainfall simulation

At the end of the planting period, sample of soil aggregates was prepared for each treatment by gently breaking the soil clods at soil moisture content near to plastic limit into pieces. Thereafter, they were air dried and a subsample was obtained from the materials, each weighing a 2 gm. The selected aggregates were placed in desiccators for complete drying. The raindrop simulator installed at 1.3 m height to form raindrops of 0.2 ml in volume. The number of simulated rain drops required to disintegrate aggregate and to pass through the 2 mm sieve and its surface area was 0.012 m^2 was recorded. This test was replicated three times; the required time (s) was noted and used to calculate the kinetic energy to disintegrate the aggregates from this formula:

$$KEt = \left(\frac{36000/Te}{Ad}\right);$$ (Salles et al., 2002; Xiao et al., 2017)

Where,

KE_t = kinetic energy (J $m^{-2}hr^{-1}$)

T = time (s) required by the simulated rainfall to break the aggregate.

e = theoretical formula for kinetic energy.

Ad= area of rainfall impact (m^2).

36000= constant concerning others variable in calculating simulated rainfall.

Data analysis

Data collected from the field were subjected to Analysis Of Variance (ANOVA) of Minitab 16 software package and Least Significant Difference (LSD) was used to separate the means.

Results and discussion

The result of the soil used as presented in (Table 1) indicated that the soil was slightly acidic, 5.9 – 6.2 (Adepetu et al., 2014); this was possible due to high content of quart which was also confirmed by the textural class of the soil being sandy (sand 80%, silt 10.8%, clay 9.2%), but the poultry manure sample revealed alkaline (8.4 – 8.7), therefore, improved the soil pH , also the cement sample being a calcinned salt had more of calcium derivatives (CaO- 66% mass) than other products which consequently improved the nutritional content of the soil (Table 2).

Table 1. Physical and chemical properties of soil and poultry manure used.

Parameters	**Soil**	**Poultry manure**
	Values	
P^H (in H_20)	6.2	8.7
P^H (in KCl)	5.9	8.4
Available Phosphorous	3.90	1.06
Organic carbon (g^{-1} kg)	5.30	42
Organic Matter (g^{-1} kg)	9.10	76
Total Nitrogen (g^{-1} kg)	0.50	0.48
Exchangeable bases (mol^{-1} kg)		
Na	0.59	0.46
K	0.35	0.96
Ca	0.92	11.2
Mg	2.68	0.92
Particle size distribution (g^{-1} kg)		
Sand	800	
Silt	108	
Clay	92	
Textural class	Sandy	

Table 2: Chemistry of Portland cement and water used.

Cement	**mass %**	**water**
CaO	66	_
SiO_2	21	_
Al_2O_3	6	_
Fe_2O_3	5	_
SO_3	2	_
Ec (dsm^{-1})		0.10
pH	10.7	7.1
Soluble cations and anions (mmole ^{-1}L)		
Ca^{2+}		1.00
Mg^{2+}		0.02
Na^{1+}		0.09
K^{1+}		0.01
Cl^{-1}		0.03
SO_4^{-2}		0.04
CO_3^{-2}		0.00
HCO_3^{-1}		0.53

The average time (s) and kinetic energy used by the artificial simulated rainfall which measured the soil aggregate stability (Table 3) indicated that the least time and kinetic energy (7 and 8 s; 14.2, 15.2 and 16.6) and the highest time and kinetic energy (16, 15 and 20 s; 31.2, 30.4, 40.1 J $m^{-2}hr^{-1}$) were obtained from all the control treatments and at the highest levels of soil amended treatments respectively. The analysis of variance (Table 4) observed that the soil amended with poultry manure, portland cement and combined poultry manure plus portland cement had increased statistical significant effects on time and kinetic energy to disintegrate the soil aggregate (the higher the level of soil amendments, the higher the time and kinetic energy required to disintegrate the soil aggregate) which indicated that soil aggregate were more stable as the level of treatments increased. These results were in agreement with Mathers and Stewart (1980).

Table 3: The effects of poultry manure, cement and poultry manure plus cement on the average time (s) and kinetic energy of simulated rainfall to break the soil aggregate and growth parameters of pepper (n = 36 x3).

Parameters	**Poultry manure (gm)**			**Portland cement (gm)**				**Poultry plus P. cement (gm)**			
0	10	20	30	0	10	20	30	0:0	5:5	10:10	15:15
T (s) 7c	11b	11b	16a	8c	12b	15a	15a	8c	12b	19a	20a
KEt 14.2c	21.1b	20.0b	31.2a	15.2c	23.6b	30.1a	30.4a	16.6c	23.9b	37.7a	40.1a
NL 8b	9b	11a	12a	10b	15a	16a	16a	9c	12b	19a	14b
PH (cm) 11.7c	15a	17.5a	19.1a	12.3c	15.3b	18a	18.7a	13.3b	21a	15.7b	23a
LA (cm^2) 8c	13.2b	19.1a	20a	10.3c	21.3a	18.7b	19b	9c	21.7b	27a	20.7b
NR 49c	64b	75a	80a	50c	96a	71b	76b	47c	84b	95a	98a
SG (zm) 0.3b	0.4b	0.6a	0.7a	0.4ns	0.5ns	0.5ns	0.5ns	0.4c	0.9b	0.9b	2,2a
RG (cm) 0.2c	0.4b	0.5a	0.6a	0.3c	0.5a	0.6b	0.5a	0.4c	0.6b	0.7a	0.8a
RL (cm) 6.7b	8.3a	9.7a	9.4a	6.1ns	7.3ns	6.7ns	7.3ns	6.1b	5.7b	8.1a	8.3a

Means that do not share a similar letter are significantly different at (P= 0.05.)
Notes: Time (t), KEt (Kinetic energy at time t), Number of leaves (NL), Plant height (PH), Leaarea (LA), Number of roots (NR), Stem girth SG), Root girth (RG), Root length (RL).

Table 4: Analysis of variance of the effects of poultry manure, cement and poultry manure plus Portland cement amended soil on the average time (s) and kinetic energy of simulated rainfall to break the soil aggregate and growth parameters of pepper, (n = 36 x3).

Parameters	**Poultry manure (PM)**		**Portland cement (PC)**		**Poultry manure +Portland cement**	
	ms	**P value**	**ms**	**P value**	**ms**	**P value**
T (s)	38.00**	0.001	37.89**	0.000	40.49**	0.000
KEt	19.64**	0.000	21.35**	0.000	42.17**	0.000
NL	12.22**	0.004	25.64**	0.000	52.97**	0.000
PH	30.91**	0.001	24.97**	0.001	60.97**	0.002
LA	93.09**	0.000	69.56**	0.000	85.44**	0.000
NR	571.42**	0.000	1053.86**	0.000	2614.20**	0.000
SG	0.12*	0.030	0.01ns	0.370	1.87**	0.000
RG	0.06*	0.020	0.04**	0.001	0.10**	0.008
RL	5.26**	0.001	1.01ns	0.400	12.03**	0.000

**Significant at $P \leq 0.01$
*Significant at $P \leq 0.05$
ns = not Significant at $P \leq 0.05$
ms = mean square
P-v = probability value
Notes: Poultry manure (PM), Portland cement (PC), Time (t), KEt (Kinetic energy at time t), Number of leaves (NL), Plant height (PH), Leaf area (LA), Number of roots (NR), Stem girth SG), Root girth (RG), Root length (RL).

Poultry manure increased all the agronomic parameters measured from control to 30 gm except root length from control to 20 gm of poultry manure amendment; the number of leaves (8 – 12), plant height (11.7–19.1 cm), leaf area (8 – 20 cm^2), number of roots (49 – 80), stem girth (0.3 – 0.7cm) root girth (0.2 – 0.6cm) and root length (6.7–9.7 cm) (Table 3). The observed increased in the size of leaf area implies that there was an effective utilization of nutrients from the soil. This result was in agreement with Aliyu (2003) and confirmed the ability of poultry droppings to supply the required Nitrogen contents needed by pepper plants to improve their growth and general performance (Alabi, 2006). The analysis of variance of the effects of poultry manure on the average agronomic parameters of pepper plant, (Table 4) observed that poultry manure had increased statistical significant ($P \leq 0.01$) effects on the number of leaves, plant height, leaf area, number of roots, roots length and statistical significant ($P \leq 0.05$) effects on stem girth and roots girth of pepper plant, These results are in accordance with the findings of Alabi (2006), the LSD, however, showed that the control and 10 gm of poultry manure had the same effect ($P = 0.05$) on the number of leaves, the same effect was also observed with 20 and 30 gm of poultry manure, quantities of 10, 20 and 30gm had the same ($P = 0.05$) effect on the pepper height but statistical different from the control, 20 and 30 gm of poultry manure had the same ($P = 0.05$) effect on the leaf area and number of roots, while control and 10 gm had different ($P = 0.05$) effects on the pepper leaf area and number of roots, both control and 10 gm of poultry manure had the same ($P = 0.05$) effect on the stem girth, the same trend was observed with 20 and 30 gm, 20 and 30 gm of poultry manure had statistically ($P = 0.05$) same root girth which was different from the control and 10 gm of poultry manure, the root length of the control bowl was only statistically ($P = 0.05$) different from other treatments of 10, 20 and 30 gm (Table 3). This result agreed with the reports of Stevenson and Ardakani, (1972) and Udoh et al., (2005) who established that organic manure can improve soil chemical and physical properties which enhanced growth and development of plants.

Portland cement amendment improved all the following agronomic parameters; number of leaves (10 – 16), plant height (12.3 – 18.7 cm), leaf area (10.3 – 21.3 cm^2), number of roots (50 - 76), stem girth (0.4 – 0.5 cm), root girth (0.3 – 0.5 cm) and root length (6.1 – 7.3 cm), however, these increments were less pronounced than the poultry manure amendment (Table 3). The analysis of variance (Table 4) of effect of portland cement on the average agronomic parameters of pepper plant, observed that the portland cement quantities had statistical significant ($P \leq 0.01$) effects on number of leaves, plant height, leaf area, number of roots, root girth and no statistical significant ($P \leq 0.05$) effects on stem girth and root length. Means separation by LSD of the average growth parameters showed that the control was only statistically ($P = 0.05$) different from others treatments on the number of leaves, the plant height and number of roots at 20 and 30 gm of cement was the same ($P = 0.05$) and ($P = 0.05$) different from control and 10 gm of cement. The number of roots at 20 and 30 gm of portland cement was statistically the same and statistically different from control and 10 gm of portland cement amendment. The root girth at 10 and 30 gm had statistical ($P = 0.05$) the same root girth and statistically ($P = 0.05$) different from control and 20 gm cement.

Poultry manure plus portland cement amendments in ratios increased all the average agronomic parameters of pepper plant more than individual poultry manure or portland cement; number of leaves (9 – 14), plant height (13.3 – 23 cm), leaf area (9 – 20.7 cm^2), number of roots (47 – 98), stem girth (0.4 – 2.2), root girth (0.4 – 0.8 cm) and root length (6.1 – 8.3 cm) (Table 3). The analysis of variance (Table 4) of the effect of poultry manure plus portland cement showed that there was statistical significant ($P \leq 0.01$) effects on all the average agronomic parameters; number of leaves, plant height, leaf area, number of roots, stem girth, root girth and root length. The LSD separated the significant means of effects of combined treatment; 5:5 and 15:15 gm of the combined amended treatment gave the same statistical ($P = 0.05$) number of leaves and statistically ($P = 0.05$) different from the control and 10:10 gm of the combined treatment. Control and 10:10 gm or 5:5 and 15:15 gm of

combined treatments resulted to statistically (P = 0.05) the same plant height. 5:5 and 15:15 gm of combined treatments resulted to statistically (P = 0.05) the same leaf area and statistically (P = 0.05) different from control and 10:10 gm combined treatment. 10:10 gm and 15:15 gm gave statistically (P = 0.05) the same number of roots and root girth and different from the control and 5:5 combined treatments. The combined treatment indicated the same statistical (P = 0.05) stem girth at 5:5 and 10:10 gm and statistically (P = 0.05) different from the control and 15:15 combined treatment. The combined treatments of poultry manure plus Portland cement at control, 5:5gm and 10:10, 15:15gm gave the same statistical (P = 0.05) effect on the root length respectively (Table 3).

Conclusion and recommendation

Research was carried out to determine the effects of poultry manure, portland cement and poultry manure plus portland cement on the average time (s) and kinetic energy of simulated rainfall to break the soil aggregate and growth parameters of pepper (*Capsicum annuum*) on a sandy soil of The Oke – Ogun Polytechnic located in the Oke - Ogun area of Oyo State, derived savannah of South West, Nigeria, in a complete randomized design (CRD) with four treatments of poultry manure, portland cement and combination of poultry manure plus portland cement, all the treatments were replicated three times. Results indicated that poultry manure, portland cement and combined poultry manure plus portland cement increased the average time (s) and kinetic energy of simulated rainfall to break the soil aggregate more than the controls, and all the growth parameters of pepper, however, the increments was more pronounced in the combined treatments than others.

The analysis of variance showed that poultry manure, portland cement and combined poultry manure plus portland cement had statistical significant ($P \leq 0.01$) increased effects on the average time (s) and kinetic energy of simulated rainfall to break the soil aggregate, also poultry manure and combined poultry manure plus portland cement had statistical significant ($P \leq 0.01$) improvement on all the growth parameters, but, the strength of improvement ($P \leq 0.05$) was less in poultry manure amended soil on stem girth and root girth. Portland cement analysis of variance on average agronomic parameters of pepper showed that portland cement had statistical significant ($P \leq 0.01$) improvement on five growth parameters and no significant ($P \leq 0.05$) effects were recorded on stem girth and root length. It was also noted that ten (10 gm) of poultry manure distinctly had statistical significant ($P \leq 0.01, 0.05$) improvement on three (3) agronomic parameters of pepper; leaf area, number of roots and root girth. Portland cement only had distinct statistical significant ($P \leq 0.01$) improvement on four (4) agronomic parameters of pepper, 10 gm on three (3); plant height, leaf area and number of roots; and 20 gm on root girth. Poultry manure plus portland cement combined had distinctly statistical significant increments on five (5) agronomic parameters; 5:5 gm on number of roots and root girth, 10:10 gm on number of leaves and leaf area and 15:15 gm on stem girth.

Therefore, based on the results from the experiment, statistical analysis, the magnitude of the results and cost; the combined treatment of poultry manure plus portland cement at 10:10 gm is hereby recommended for the improvement of the soil aggregate and the growth of pepper in a sandy soil in derived savannah.

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References

Adamson, E., H.; Seppelt, R. 1994. Cement dust contamination of *Ceratodon purpureus* at Casey, East Antarctica: Damage and capacity for recovery. J. Bryol 18:127-137

Adegunloye, D. V.; Adetuyi, F. C.; Akinyosoye, F. A.; Doyeni, M. O. 2007. Microbial analysis of compost using cow dung a booster. Pak. J. Nutr.6 (5): 506 – 510

Adepetu, J.A.; Adetunji, M. T.; Ige, D.V. 2014. Soil Fertility and Crop Nutrition; Soil acidity and liming,106

Alabi, D. A. 2006. Effect of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annum*

L.). African Journal of Biotechnology 5(8): 671 677

Aliyu, L. 2000. The effect of organic and mineral fertilizer on growth yield and composition of pepper (*Capsicum annum L.*) Biol Agric Hort 18: 29-36

Aliyu, L. 2003. Effect of manure type and rate on the growth, yield and yield component of pepper (*Capsicum annum L.*) J. Sustain Agric Environ 5:92-98

Amadi, A.; Ile Bari, Y. 1992. Use of poultry manure for amendment of oil polluted soils in relation to growth of maize (*Zea mays L*). Environ.Int 18:521-527

Amadi, A.; Dickson, A. A.; Maate, G. O. 1993. Remediation of Oil Polluted Soils. I. Effect of organic and Inorganic Nutrient Supplements on the Performance of Maize (*Zea Mays L*). Water Air Soil Pollut.66:59-76

Azam, R. A. I. 1980. Agricultural polymers, Polyacrylamide preparation, application and prospects in soil conditioning. Comm. Soil Sci. Plant Anal 11:767–834

Bremner, J. M. 1996. Total Nitrogen. In: Sparks, D.L., Ed., Methods of Soil Analysis, Part 3, Chemical Methods, SSSA and ASA, Madison 1123-1184

Bouyoucous, G. H. 1962. Hydrometer Method Improved for Making Particle Size Analysis of Soils. Agronomy Journal 54:464-465

De Boodt, M. F. 1993. Soil conditioning a modern procedure for restoring physical soil degradation. Pedologie 43:157-195

Flores, P.; Hellin, P.; Fenoll, J. 2009. Effect of manure and mineral fertilization on pepper nutritional quality. Journal of Science, Food and Agriculture 89(9):1581-1586

Fornis, R. L.; Vermeulen, H. R.; Nieuwenhuis, J. D. 2005. Kinetic energy-rainfall intensity relationship for Central Cebu, Philippines for soil erosion studies. Journal of Hydrology 300:20-32

Gee, G. W.; Or, B. D. 2002. Particle size analysis. In: J. H. dane and G. C. Topp (eds). Methods of soil analysis part 4:255-293

Jablonski, C. K. G. 1990. Straw as an organic fertilizer in cultivation of vegetables. Part II. Effect of fertilization with straw on the growth of vegetable plants. Hort Abstr. 63:244

Jadczak, D.; Grzeszczuk, M.; Kosecka, D. 2010. Quality characteristics and content of mineral compounds in fruit of some cultivars of sweet pepper (*Capsicum annuum L.*). J Elementol 15(3):509–515

Kuo, S. 1996. Phosphorus. In: Sparks, D.L., Ed., Methods of Soil Analysis, Part 3, Chemical Methods, SSSA and ASA, Madison 869-920

Mandre, M. 1997. Changes in a forest landscape affected by alkaline industrial dust. Oil Shale 14: 409 - 418

Mandre, M. K.; Ots, J. R.; Tuulmets, L. 1998. Impact of air pollution emitted from the cement industry on forest bioproduction. Oil Shale 15: 353-364.

Mathers, A. C.; Stewart, B. A. 1980. The effect of feedlot manure on soil physical and chemical properties. Livestock wastes. A renewable Resource. American Society of Agricultural Engineers, 159-162

Obire, O.; Akinde, S. B. 2004. Poultry manure amendments of oil polluted agronomic soils for sustainable development in the Niger Delta. J.Nig.Environ.Soc 2(2):138-143

Olaniyi, J. O.; Ojetayo, A. E. 2010. The effect of organomineral and inorganic fertilizers on the growth, fruit yield and quality of pepper (*Capsicum frutescence*). J. Animal and Plant Sciences 8 (3): 1070-1076

Shanmuganathan, R. T.; Oades, J. M. 1982. Effect of dispersible clay on the physical properties of the B horizon of a red-brown earth. Aust. J. Soil Res 20:315-324

Salles, C. H.; Poesen, J.; Sempere-Torres, D. 2002. Kinetic energy of rain and its functional relationship with intensity. Journal of Hydrology 257: 256-270

Stevenson, F. S.; Ardakani, M. S. 1972. Organic matter reactions involving micronutrients in soil. In: Mortved. J. J., Giordano, P. M. and Lindsay, W. L. (eds.), Micronutrient in Agriculture. Madison, Soil Science Society of America. pp. 79-114

Thomas, G.W. 1996. Soil pH and soil acidity. In: Sparks, D. L. (ed). Methods of Soil Analysis. Part 3.Chemical Methods. SSSA and ASA. Madison, WI. 475-490

Udoh, D. J.; Ndon, B. A.; Asuquo, P. E.; Ndaeyo, N. U. 2005. Crop Production Techniques for the

Tropics. Concept Publication, Lagos, Nigeria. 446

Ullah, M. S.; Islam, M. S.; Islam, M. A.; Haque T. 2008. Effects of organic manures and chemical fertilizers on the yield of brinjal and soil properties. J. Bangladesh Agril. Univ 6(2): 271-276

Van Dijk, A. M. 2002. Rainfall intensity-kinetic energy relationship: a critical literature appraisal. Journal of Hydrology 261:1-23

Walkley, A. C.; Black, T. A. 1935. Estimation of soil organic carbon by chromic acid titration method. Soil Sci 47: 29-38

Wiel, R. R.; Kroonje, W. 1979. Physical conditions of Davidson clay loam after five years of poultry manure application. J. Environ. Qual. 18:387-392

Watson, E. B.; Wark, A.; Thomas, J. B. 2006. Crystallization thermometers for zircon and rutile, Contrib Mineral Petrol 151:413-433

Xiao, H.; .Liu, G.; Abd-Elbasit, M. A. M.; Zhang, X. C.; .Liu, P. L.; Zheng, F. L.; Zhang, J. Q.; Hu, F. N. 2017. Effects of slaking and mechanical breakdown on disaggregation and splash erosion. European Journal of Soil Science 68:797-80

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