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Research Article

EFFECT OF FRESH RUMEN DIGESTA ON SOIL CHEMICAL PROPERTIES AND YIELD OF CUCUMBER (*CUCUMIS SATIVUS*) IN ABAKALIKI SOUTHEAST NIGERIA

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ABSTRACT
Modern farming is emphasizing on organic farming and de-emphasizing the use of chemical fertilizer because wastes can supply virtually all the nutrients required by plants and improves soil Chemical and biological conditions for sustainable crop production and environmental safety .Based on the above premise an field experiment was conducted at the Teaching and Research, Farm of the Faculty of Agriculture and Natural Resources Management, Ebonyi State University Abakaliki during the 2010 cropping season to evaluate the effect of fresh rumen digesta on soil chemical properties and yield of cucumber (*Cucumis sativus*). The experiment was laid out in a randomized complete block design (RCBD) with five treatments and five replications. The treatments comprised of 0t/ha, 1t/ha, 2t/ha, 3t/ha and 4t/ha. The results showed that soil pH, organic matter, total nitrogen, available phosphorus, exchangeable bases, effective cation exchange capacity and base saturation were significantly (P=0.05) improved following fresh rumen digesta incorporation. The plant parameters studied showed that fruit yield (t/ha) and fruit weight (kg/fruit) improved significantly but fruit length and fruit circumference were not significantly improved. The trend of the improvement of the soil properties and yield of the cucumber was 4t/ha > 3t/ha > 2t/ha > 1t/ha > 0t/ha. It is recommended that farmers can improve on soil chemical properties and the yield of cucumber by the application of 4t/ha of fresh rumen digesta.

***Key Words**: Abakaliki, Cucumis, Chemical Digesta, Yield, Rumen, Southeast*

INTRODUCTION
It is known that continuous cropping on a piece of land without adequate use of chemical fertilizers or manures lower soil fertility and crop yield (Agboola and Odeyeni, 1972).
Modern farming is emphasizing on organic farming and de-emphasizing the use of chemical fertilizer because wastes can supply virtually all the nutrients required by plants and improves soil physical and biological conditions for sustainable crop production and environmental safety (FAO, 1976). These wasted can also add to the pool of organic matter contents of tropical soils which have been reported to be a major problem militating against the yield of crop in this area (Mbah *et al.,* 2007; Onweremmadu *et al.,* 2008). Cucumber (*Cucumis sativus)* is an ancient vegetable and one of the most improvement members of the cucurbitaceae family (Thao, 1998). It is native to African and Asia where it has been consumed for 3,000 years. It is cultivated for its fruit which is a rich source of minerals and vitamins. The fruit is eaten fresh alone as salads and in combination with other vegetables.
Soil where cucumber is cultivated require moderate to high nutrient levels so as to achieve high yields. Infertile soils result in bitter and misshapen fruits which are often rejected by consumers (Eifefiyi and Remision, 2009).
Soils in Ebonyi State Agro ecological zones of southeast Nigeria are poor in their native availability of basic nutrients for optimum crop production (Ekpe, 2010). In the past, soil fertility is maintained in the southeastern Nigeria via prolonged bush fallow (5-10yrs) (Unamma *et al.,* 1985). However increase in population has resulted to reduced fallow periods leading to poor crop yield. Rumen digesta are waste from abattoirs that are presently a menace in most cities of developing countries.

The use of these wastes as plant nutrient source has not received much research attention in Nigeria. It is against this backdrop that effort was made to study the effect of fresh rumen digesta on soil chemical properties and yield of cucumber.

MATERIALS AND METHODS

1. Site Description

The experiment was conducted at the Teaching and Research Farm of the Faculty of Agricultural and Natural Resources Management, Ebonyi State University, Abakaliki. The area lies within longitudes $08^0.03^{'}$E and latitudes $06^0.25^1$N in the derived savannah zone of South East Nigeria. The area is characterized by a bimodal rainfall pattern with mean annual rainfall of 1700mm. The mean monthly temperature ranged between 28^0C and 34^0C. The rainfall pattern is bi-modal with peak periods in the months of July and September. Relative humidity is high (80%) during raining season and declines to less than 65% during dry season (Ofomata, 1975). The soil belongs to the order ultisol and is classified as typic Haplustult (FDALR, 1985).

2. Field Layout/Experimental Design

At the onset of the experiment in June 2010, the predominant vegetation was cleared using machetes after which raised seed beds were made using traditional hoe. The experiment was laid out in a randomized complete block design (RCBD) with five treatments replicated five times. The main plot measured 2 x 15 m^2. The 2 x 15 m^2 sizes were the blocks wile each of the blocks were further sub-divided into 5 small plots of 2 x 2 m^2 size each. A total of 25 plots with total land area of 194 m^2 were used. The treatments comprised of 0t/ha, 1t/ha, 2t/ha, 3t/ha and 4t/ha of fresh rumen digesta sourced from the central abattoir located at Abakaliki town. The fresh rumen digesta were incorporated into the soil and allowed to stand for two weeks before seed placement so that the heat of decomposition will not affect seed germination.

3. Planting

Planting of the cucumber seed was done by direct seeding two weeks after the incorporation of the fresh rumen digesta. The planting was done at a spacing of 50 x 50 cm. Cucumber variety Poinsett was used and three seeds were sown per hole and latter thinned down to one, two weeks after emergence (2WAE). Weeds were controlled by hand picking to keep the plots free from weeds as regularly as the need arose. The crop was protected against pest attack by spraying Endecott 35 emmulsifiable concentrate twice during the period of the research.

Four plants were tagged in each net plot from which agronomic parameters such as , total fruit yield, weight of individual fruits, fruit length and fruit circumference were measured. Harvesting was done at 54 DAP by hand picking. At this stage the cucumber plant has turned from dull green colour to glossy green. A total of four harvests were made during the period of the experiment. The number of fruits harvested per plot in the net plot was summed up to get the total fruit yield. Fruit length was measured after each harvest using meter rule. Fruit circumference was measured using tailors tape and total fruit weight was measured using weighting balance.

4. Soil Analysis

Initial and final soil samples were collected from 0-20cm depths using soil Auger attached to soil sampler and was taken to the laboratory for analysis of some selected soil chemical properties.

Soil pH was determined using glass electrode pH meter in water in the ratio of 1:2.5 (Maclean, 1982) organic carbon was by Wakley and Black (1954). Organic matter was gotten by multiplying organic carbon by a factor of 1.724. Total nitrogen was determined by using microkjeldahl apparatus (Bremner, 1983). Available phosphorus was determined according to the procedure of Olsten and Summers (1982). Exchangeable base by ammonium acetate leaching and exchangeable acidity by titration (Maclean, 1982). Base saturation was determined by calculations.

$$\frac{\text{Exchangeab le Bases}}{\text{Cation Exchange Capacity}} x100$$

The effective cation exchangeable capacity was determined by summation of exchangeable bases and exchangeable acidity. All data collected was analyzed statistically based on the procedures for a randomized complete block design (RCBD) as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The result of the pre-planting soil analysis is presented in table 1.

Table 1: Pre-Planting Soil Analysis

parameter	value
pH(H_2O)	5.4
Organic matter	2.10%
Total nitrogen	0.018%
Available phosphorus	27.00 Cmol/kg
Calcium	3.32 Cmol/kg
Magnesium	2.40 Cmol/kg
Potassium	0.102 Cmol/kg
Exchangeable acidity	1.76 Cmol/kg
Base Saturation	68.11%

Effects of Fresh Rumen Digesta on Soil Macronutrient

The results of the effects of fresh rumen digesta on soil macronutrients are presented in table 2:

Ph

There was significant difference (P=0.05) when the result of the soil pH of the control was compared with the treatments and when the treatments were compared with one another. One tone per hectare of the treatment reduced soil acidity by 0.2 units when compared with 0t/ha while there was further improvement in soil pH of the treated soil by 1.0, 1.4 and 0.49 units when 0t/ha was compared with 1t/ha, 2t/ha, 3t/ha and 4t/ha respectively. Four tons per hectare treatment improved soil pH tremendously. There was a shift from strongly acid to moderately acid. The improvement in soil pH observed in the amended plots confirmed the liming effects of agro-wastes similarly reported by Okonkwo *et al.,* (2009), Duruigbo *et al.,* (2006), Anon and Ubochi, (2007) and Chukwu, (2001).

O/M

Fresh rumen digesta significant improved soil organic matter when the control plot was compared with the treated plots. There was also significant difference in organic matter of the treated soils when they were compared with one another. The application of fresh rumen digesta increased organic matter content of the soil by 67, 7, 83.3, 90.3 and 108.3% respectively when compared with the control. Fresh rumen digesta at 2t/ha treatment produced 9.5% more organic matter than 1t/ha rate of treatment while 3t/ha application rate produced 24.3% more than 1t/ha treated plots. Three tons per hectare treatments produced 9.4% more O/M than 2t/ha.

The highest organic matter addition to the soil was achieved when 4t/ha of fresh rumen digesta was applied to the soil. The result obtained may be as a result of increased organic carbon and mineralization

of the fresh rumen digesta. This is consistent with the findings of NRCS (1996) which noted that applying animal manure increase the supply of organic matter in the soil.

Per cent Total Nitrogen (%TN)

The addition of fresh rumen digista to the soil improved the total Nitrogen when the control was compared with the treatments. There was also improvement of total nitrogen when the treatments were compared with one another. There was more than 800% improvement in total N among the soils treated with fresh rumen digesta. The highest improvement was recorded in the plots treated with 4t/ha followed by 2t/ha, 3t/ha and 1t/ha respectively.

This resulted from the incorporation of rumen digesta and agrees with the findings of Awodun (2008) and Okonkwo *et al.,* (2009) who noted that mineralization of organic wastes results in the release of organic bound nutrients in the soil notably N.P.K and Organic matter

Available Phosphorus

The available phosphorus of the soil improved tremendously when the values recorded in the control was compared with the treatments. There was also improvement within the different levels of treatment, there was 7.06 Cmol/kg available P. when the control was compared with 1t/ha fresh rumen digesta. Also 2t/ha, 3t/ha and 4t/ha treatment levels recorded 8.99, 10.06 and 11.06 Cmol/kg more available P, respectively over the control. Four tons per hectare fresh rumen digesta had the greater effect on available phosphorus than the other levels. The mean values recorded ranged from 22.81-33.87 Cmol/kg indicating that the P content of the soil was at medium level Enwezor *et al.,* (1989). This agrees with the findings of Awodum, (2008) who reported an increase in soil phosphorous as a result of addition of rumen digesta.

Exchangeable Cations

Calcium (Ca)

Calcium content of the soil improved with the addition of the fresh rumen digesta. The different levels of rumen digesta added to the soil also recorded different significant results. There was significant difference when 1t/ha fresh rumen digesta was compared with 2, 3 and 4t/ha. There was also significant difference when 2t/ha was compared with 3t/ha and 4t/ha. Also 3t/ha differed from 4t/ha significantly. The control plot recorded 0.86 Cmol/kg less calcium than when 1t/ha of fresh rumen digesta was added to the soil. Treatment rates of 1, 2 and, 3t/ha had 1.42, 1.58 and 1.85 Cmol/kg exchangeable calcium more than the untreated soil. Again 2t/ha, 3t/ha and 4t/ha recorded 0.56, 0.72, and 0.97 mg/kg more exchangeable calcium than the plots treated with 1t/ha. Furthermore, the plots treated with 2t/ha of fresh rumen digista also produced 0.16mg/kg and 0.4/mg/kg exchangeable calcium than the soil treated with 3t/ha and 4t/ha fresh rumen digesta respectively. There was superior improvement of soil exchangeable calcium by the amended plots than the control.

Magnesium (Mg)

There was significant difference in the soil magnesium content when the results of the control was compared with results of the amended plots and when treatments level 1 was compared with treatment levels 2, 3 and 4. Also there was significant improvement when 2t/ha was compared with 4t/ha and when 3t/ha treatment level was compared with 4t/ha treatment level. There was no significant difference in magnesium content of the soil at plots treated with 2t/ha when compared with the magnesium content of the soils treated with 3t/ha fresh rumen digesta. Furthermore, the addition of fresh rumen digesta improved the soil magnesium by 0.55, 0.85, 1.01 and 1.79 mg/kg at 1, 2, 3, and 4t/ha respectively when compared with the control. One ton per hectare fresh rumen digesta addition to the soil recorded 0.3, 0.46 and 1.24 mg/kg of less magnesium than 2, 3 and 4t/ha treatment levels respectively. On the other hand, 4t/ha recorded 0.94 and 0.78 more magnesium than 2t/ha and 3t/ha of fresh rumen digesta treated soils.

Potassium (K)

There was no significant difference in soil K when the control plot was compared with 1t/ha and when 1t/ha was compared with 2t/ha and when 2t/ha was compared with 3t/ha fresh rumen digesta treatment

levels. There was significant differences when the control was compared with 2t/ha, 3t/ha and 4t/ha treatment levels. Also there was significant differences when 1t/ha treatment level was compared with 3t/ha and 4t/ha treatment levels. Three ton per hectare treatment level also differed from 4t/ha treatment levels significantly. Further, there was 0.069 and 0.095 Cmol/kg significant improvement in K content of the 2t/ha and 3t/ha treated soil when compared with the control. There was also 0.04, 0.066 and 0.173 Cmol/kg more K in the soils treated with 2, 3 and 4t/ha fresh rumen digesta when compared with the K values recorded in plots treated with 1t/ha fresh rumen digesta treatment levels. Again 4t/ha recorded high 0.133 and 0.107 Cmol/kg K than 2 and 3t/ha treated soil.

Sodium (Na)

There was no significant improvement in soil sodium content when the untreated soil was compared with 1t/ha fresh rumen digesta treated plot. There was 0.05, 0.07 and 0.64 Cmol/kg significant increase soil sodium when the control plot sodium content was compared with the 2, 3 and 4t/ha fresh rumen digesta treated plots respectively when the treatments were compared with one another, there showed 0.04, 0.06 and 0.63 Cmol/kg more sodium when 1t/ha fresh rumen digesta treated soil/plot was compared with 2, 3 and 4tt/ha fresh rumen digesta treated plots. Again treatment plots with 4t/ha recorded 0.59 and 0.59 significantly more sodium when compared with 2t/ha and 3t/ha fresh rumen digesta treated soil. And 3t/ha produced 0.57 less sodium than 4t/ha fresh rumen digesta treated plots.

On the whole the concentrations of the exchangeable cations in the amended plots improved significantly. This shows that fresh rumen digesta improved the exchangeable bases content in the soil. The increase in values may be as a result of increased soil pH which invariably has a liming effect on the soil and agrees with NRCS, (1998) which noted that increase in soil pH increases the availability of exchangeable bases. Increases in exchangeable bases due to application of organic residues have been reported by Mbagwu (1992).

ECEC

The effective cation exchange capacity of the control plots recorded significantly less ECEC than the treated plot. And there was statistically significant difference in ECEC when the different treatment levels were compared with one another. The control recorded 2.42, 2.6, 3.0 and 4.14 Cmol/kg less ECEC than the plots treated with 1, 2, 3 and 4t/ha fresh rumen digesta respectively. Again 0.18, 0.58 and 1.72 Cmol/kg ECEC improvement was recorded for 2, 3 and 4t/ha fresh rumen digesta treatments respectively when compared with 1t/ha fresh rumen digesta treatment levels.

Three tons per hectare fresh rumen digesta treated soil recorded 0.4mg/kg more ECEC when compared with 2t/ha. But 4t/ha improved the soil ECEC by 1.14 Cmol/kg over 3t/ha. The ECEC of the amended plots range form 6.34-10.48 (Cmol/kg) indicating an increase in the soils ECEC. This agrees with NRCS (1996) which noted that organic matter retains nutrients by providing cation and anion exchange capacities.

% Base Saturation

The result of the per cent base saturation of the control plots showed significant improvement of the fresh rumen digesta treated plots when compared with the control.

There was also significant improvement of percent base saturation when the different treatment levels were compared with one another. The plots amended with 1, 2, 3 and 4t/ha improved the base saturation by 8.3, 11.24, 14.6 and 21.9% relative to the control. Again there was also a trend of improvement throughout the treatment levels. The improvement in percent base saturation increased as the quantity of the fresh rumen digesta increased. The plots treated with 2, 3 and 4t/ha recorded 2.71, 5.8 and 12.45% more saturated base than plots treated with 1t/ha. Plots treated with 3 and 4t/ha also produced 9.0 and

9.46% more bases than 2t/ha treated plots. The plots treated with 3t/ha produced 6.29% less % base than 4t/ha fresh rumen digesta treated soils.

Table 2: Effect of Fresh Rumen Digesta on Some selected Soil Chemical properties

Treatment	pH (in H_2O)	Om	%Total N	AV.P	Ca	Mg	K Cmol/kg	Na	ECEC	%BS
0t/ha	5.49	1.56	0.012	22.81	3.32	1.86	0.112	0.08	6.34	68.45
1t/ha	5.51	2.61	0.113	29.87	4.18	2.41	0.141	0.09	8.76	74.11
2t/ha	5.59	2.86	0.126	31.80	4.74	2.71	0.181	0.13	8.94	76.12
3t/ha	5.63	2.97	0.121	32.87	4.90	2.87	0.207	0.15	9.34	78.41
4t/ha	6.00	3.25	0.142	33.87	5.15	3.65	0.314	0.72	10.48	83.34
LSD (P=0.05)	0.19	0.09	0.004	0.66	0.05	0.22	0.031	0.02	0.08	0.75

NB: *OM = Organic Matter, EA = Exchangeable Acidity, BS = Base Saturation. ECEC=Effective Cation Exchange Capacity*

Effects of Fresh Rumen Digesta on Yield and Yield Parameters of Cucumber

Fruit Yield

There was significant difference in the fruit yield when the control plots were compared with the treated plots. But there was no significant difference when the control was compared with 1t/ha treatment rate, 1t/ha and 2t/ha, 1 and 3t/ha and 2 and 3t/ha treatment rates. Especially there were more 2.0, 3.4, 4.4 and 8.6t/ha fruit yield in 1, 2, 3 and 4t/ha treatment rates respectively when compared with the control. Treatment rate, 4t/ha produced 6.6t/ha, 5.2 and 4.2t/ha more cucumber fruit when compared with 1, 2 and 3t/ha treatment rates respectively. There is basically this trend of fresher rumen digesta application more yield. Treatment rates 1, 2 and 3t/ha had similar effect in the total fruit yield of the cucumber fruit. The increase in vine length or plant height of crops have been attributed to improved availability of nutrients especially nitrogen (Okonkwo *et al.*, 2009).

Fruit Weight

The fruit weight followed the same trend as the fruit yield. Generally there was significant increase in the fruit weight when the control was compared with the treatments rates. Just like the fruit yield result, significant differences were not found when control was compared with 1t/ha treatment rates, and when 1t/ha was compared with 2 and 3t/ha treatment rates and 2t/ha was compared with 3t/ha treatment rate. Treatment rates 2, 3 and 4t/ha increased cucumber weight by 1.20 1.56 and 2.52kg respectively when compared with the control. Again there was 1.40, 1.32 and 0.96kg significant increase in cucumber weight by the 4t/ha treatment rate when compared with 1, 2 and 3t/ha treatment rates. A weak significant difference was recorded when 2t/ha treatment application rate was compared with 4t/ha treatment rate.

This may be attributed to improved physicochemical properties and availability of plant nutrients in the soil and agrees which the findings of Okonkwo *et al.*, (2009) who obtained an increase in sweet potate yield in plots amended with different levels of defatted palm kernel cake. The results obtained for fruit weight showed that it improved significantly in all the amended plots. This may be attributed to improved plant nutrients and is consistent with the findings of Page (1966) who reported that plants grown on plots receiving organic manure were always larger than those receiving inorganic fertilizer.

There was no significant difference in the fruit length and fruit circumference of the cucumber, although there were measured differences in length and fruit circumference.
This may be attributed to slow rate of decomposition of the fresh rumen digesta. This agrees with Moyinjesu and Atoyosoye (2002) and Awodun (2008) who noted that the rate of decomposition of rumen digesta is slow.

Table 3: Effects of fresh rumen digesta on yield and yield parameters of cucumber

Treatment	Fruit yield t/ha	Fruit weight (kg/fruit)	Fruit length (cm)	Fruit Circus, (cm)
0t/ha	2.6	0.08	32.9	31.7
1t/ha	4.6	1.20	46.0	36.5
2t/ha	6.0	1.28	49.1	42.0
3t/ha	7.0	1.64	58.7	50.4
4t/ha	11.2	2.60	61.6	58.1
LSD (0.05)	3.4	0.71	NS	NS

Conclusion
In the present study, fresh rumen digesta improved soil chemical properties and yield of cucumber and can be used as a good source of manure for improving soil chemical properties and crop yield. The best rate of application of all the tested rates was 4t/ha.

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