Colloquia SSSN 44 (2020) 421-428

Colloquia Series

Available online at www.publishingrealtime.com

Colloquia SSSN 44 (2020)

Proceedings of the 44th Conference of Soil Science Society of Nigeria on Climate-smart soil management, soil health/quality and land management: synergies for sustainable ecosystem services

Planting date and manure sources; options for sustainable soil health management and yield response of soybean (Glycine Max (L)

Nwite, J. C

Department of Crop Production Technology, Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria

Abstract

Soybean is grown in many parts of Northern Nigeria, with little climatic challenges and soil organic matter. There is need to investigate possible effect of planting time of the crop in the Southeastern Nigeria where the crop looks to be stranger among other underutilized crops. A study was carried out in 2018 and 2019 cropping seasons at Federal College of Agriculture, Ishiagu, Ebonyi State, to evaluate the effect of different planting time and manure sources on selected soil chemical and physical properties, growth and yield of soybean. A split plot in a randomized complete block design (RCBD) was used with planting time (May and June) as the main plots, while six (6) soil amendments (swine manure 5t/ha, PD 5t/ha, rice husk dust 5t/ha, NPK 15:15:15 at 150kg/ha, urea at 100kg/ha and the control) replicated 3 times constituted the subplots. Plant parameters studied were pod and grain weight yield at harvest. Results showed that while soil organic carbon and total nitrogen were significantly ($p < 0.05$) influenced in 2018 and 2019 by both planting time and amendments, soil pH was significantly ($p < 0.05$) improved by soil amendments studied in the two years. Soil bulk density, mean weight diameter and carbon sequestration did vary significantly ($p < 0.05$) in 2018 and 2019 cropping season. Pod and grain weight yield were significantly ($p < 0.05$) improved in 2018 and 2019 by both planting dates and amendments. Generally, early planting time (May) gave higher soybean yield with less improvement on some soil properties as pH, soil carbon stock and mean weight diameter.

Keywords: Soybean, Planting date, Amendments, Chemical properties, Physical properties, Manure sources .

Corresponding Author's E-mail Address: johnsmallpot@gmail.com: Phone:
https://doi.org/10.36265/colsssn.2020.4457

Peer-review under responsibility of 44th SSSN Conference LoC2020.

1.0 Introduction

Soybean *(Glycine max (L) Merrell)* is the world's leading source of oil and protein. It has the highest protein in terms of all food crops and is second only to groundnut in terms of oil content among food legumes (Fekadu *et al.,* 2009: Alghamd, 2004). The spread of soybean from its native land of origins has been mainly due to its adaptability and predominant use as a food crop for human nutrition, source of protein for animals (Yusuf and Idowu 2001). Traditionally, soybean is widely grown in the middle belt or the savannah zone of Nigeria (Okpara and Ibiam, 2000), but its production had presently expanded beyond the traditional production areas of the middle belt to cover other Northern and Southern parts of the country that were otherwise considered unsuitable or marginal for soya bean production (Asiegbu and Okpara, 2002).

However, the planting time of the crop in these areas varies due to differences in weather and soil type of these areas. Planting date is an important factor affecting soybean growth and development including grain yield (Zhang *et al.,* 2010) and grain quality (Rhman *et al.,* 2005). The effect of temperature on soybean seed yield and quality also depend on the growing stages. Time of planting varies depending on the climatic condition of the region and the variety to be grown. Different varieties of soybean are sensitive to change in environmental conditions where the crop is being grown. Sowing date is the variable with the largest effect on the crop yield (Calvino *et al.,* 2003). Effects of planting date on soybean yield and other traits vary according to locations (Naeve *et al.,* 2004). Environmental conditions associated with late sowing affects crop features related to the capture of radiation and other portion of crop resources, these include vegetative growth, shorter stem and leaves including the reproductive phases (Kantolic and Slafer, 2001).

Early planting of legume crops aids in early plant cover which provide good coverage and organic matter, thus improve the physical, chemical and biological conditions of the soil and also contribute to weed control, water retention. The cover also decreases the soil bulk density due to the organic matter effect (Calegari, 2006). For centuries, organic matter has been applied to agricultural soils as a means of supplying the crops with nutrients and maintaining the required SOC content with benefits to soil structure (Balashor *et al.,* 2010). Organic substances improve soil aggregation, reduce soil compaction and surface crusting, increase carbon sequestration, nutrient availability, enhance infiltration and water holding capacity (Ohu *et al.,* 2009).

Research have shown that cropping system in relation to time of planting do influence the level of soil carbon stock in the tropics (Lal, 2003). Choosing an appropriate time for planting a particular crop will help in reducing carbon emission from agricultural lands. Determination of appropriate period of planting different crops is a strategy of improving carbon sequestration and reducing carbon accumulation in the atmosphere (Jarecki and Lal 2003).

The need to improve soil fertility and crop production to support the rapidly growing population has led to a renew interest in the use of organic sources of nutrients and mineral fertilizers for soil fertility maintenance (Ayeni *et al.,* 2009). The use of chemical (inorganic) fertilizer in crop production has not been sustainable due to its high cost and scarcity, soil acidity, increased soil bulk density, low water infiltration rate and nutrient imbalance (Ojeniyi, 1995; Nottidge *et al.,* 2005). Organic materials are often considered less likely to have detrimental effect on soil physicochemical properties compared with mineral fertilizers (Nwite *et al.,* 2016). Thus, the needs to investigate alternative sources of nutrients that will be less damaging to the soil environment become imperative. Continuous use of land with incorporation of organic and inorganic fertilizers to soil would provide multiple benefits for improving the chemical and physical states of the soil which results in improved crop yield. Organic fertilizers have traditionally been used in agricultural productions especially in view of their benefits for the soil biological and chemical properties (Queriorz *et al.,* 2004). Organic manure is also fundamental for organic carbon recycling in the soil and can improve its physical quality (Brancaliao and Morais, 2008). Organic manure improves soil aggregation, total porosity, water retention and infiltration capacity, increases the organic carbon levels, reduction of soil density, which are fundamental for the productivity capacity of the soil (Silva *et al.,* 2006).

It has been recognized in recent decades that the quality of carbon stored in soils is important on a global scale. Therefore, land management practices affecting the soil organic carbon (SOC) content may have a global impact, if they are applied over large areas (Bromick and Lal 2005). Global warming concerns have led to a surge of interest in evaluating the effect of management practices on carbon sequestration in soils (Adesodun and Odejimi, 2010). The interest is justified because soil as a sink for atmospheric $C0_2$ plays a key role in the global cycle (Eshel *et al.,* 2007).

The study therefore aimed at evaluating the effect of different planting dates and manure sources on selected soil physical and chemical properties, carbon sequestration and yield response of soybean.

2.0. Materials and Methods

2.1. Description of Experimental Site

The experiment was carried out at the research and teaching farm of Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria, during the 2018 and 2019 cropping seasons. The area is located within latitude 05^0 56^1N and longitude $07^0 41^1$E. The mean annual rainfall and mean monthly temperature have been reported as 1350mm and 30^0C, respectively. The area lies within the derived savanna vegetative zone of Southeastern Nigeria. There are two reported distinct seasons, the dry season which spans November to March, a times extend to April, and the rainy season which spans April to October (Nwite *et al.,* 2008).

Geologically the area is underlain by sedimentary rock derived from successive deposit of the cretaceous and tertiary period and lies within Asu River Group (Lekwa *et al.,* 1995).The location lies within the Asu-River Group and consists of Olive brown sandy shale, fine grained micaeous sandstones and mudstones deposited in an alternating sequence.

2.2. Field study

A split plot in randomized complete block design (RCBD) was employed to assess two factors at different levels. Two time of planting (May and June) constituted the main -plots, while the five different manure sources including the control replicated three (3) times constituted the sub-plots. The factors B treatments include; Poultry manure at 5t/ha, Swine manure at 5t/ha, Rice husk dust at 5t/ha, NPK 15:15:15 at 150kg/ha, Urea (NPK 46:0:0) at 100kg/ha and Control, while Rice husk ash was used as basal application.

The area used for the experiment was cleared and the trashes removed from the experimental site. The land was ploughed, harrowed and later made into beds manually with bed measurement of 1.5m x 1.5m which represented each net plot size. The soil amendments were applied randomly and incorporated into the soil and allowed for one (1) week for proper decomposition before planting. The rice husk ash was applied basally 2 days before planting. The soybean seeds were sown at 2 seeds per hole at a spacing of 30cm x 30cm.

Weeding operation was carried out manually at 4 and 8 weeks after planting (WAP).

2.3. Data Collection

2.3.1. Plant parameter data collection

The plant parameters where data were collected include;

Weight of pods at harvest: This was obtained by using a weighing balance to determine the weight of harvested pods according to treatments.

Weight of seeds: This was obtained by threshing the pods and getting the seeds which was measured using a weighing balance to determine the seeds weight according to treatments.

2.3.2. Soil Sampling and Laboratory Techniques

At the commencement of the experiment, a composite soil sample from random points was collected from the site using a soil auger at 0-20cm depth. Core soil sample collection was also carried out for determination of soil bulk density, total porosity, and soil moisture characteristics. At the end of the harvest, another set of auger and core samples was collected from all the identified sampling points on each of the plots from the top (0-20cm) soil depth for laboratory analysis.

Particle size distribution of the samples was determined by the hydrometer method (Gee and Bauder 1986). Soil fractions less than 2 mm from individual samples were then analyzed using the following methods; Soil pH was measured in a 1:2.5 soil:0.1 M KCl suspensions (McLean, 1982). The soil organic carbon was determined by the Walkley and Black method as described by Nelson and Sommers (1982). Total nitrogen was determined by semi-micro kjeldahl digestion method using sulphuric acid and $CuSO_4$ and Na_2SO_4 catalyst mixture (Bremner and Mulvaney, 1982).

Mean weight diameter (MWD): Mean weight diameter (MWD) of WSA (Kemper and Kosenau, 1986) was calculated as

$$MWD = \sum_{i=1}^{n} X_i W_i$$

where Xi is the mean diameter of the ith sieve size and Wi is the proportion of the total aggregates in the ith fraction. The higher the MWD values, the higher proportion of macroaggregates in the sample and therefore better stability.

Bulk density (BD): Core samples were allowed to drain freely for 24hrs before being oven dried for determination of bulk density. This was determined by calculation as:

BD = Mass of dry soil (g)/vol. of sample (cm^3) as described by the Blake and Hartge (1986) method.

Carbon sequestration: This was determined by calculation as:

$$\text{Carbon stock} = \frac{\text{Carbon(\%)}}{100} \times \text{soil bulk density X area (10,000 } m^2\text{, i.e. 1 ha) x soil depth.}$$

2.4. Data analysis

Data analysis will be performed using GENSTAT 3 7.2 Edition. Treatment means were separated and compared using Least Significant Difference (LSD) and all inferences were made at 5% Level of probability.

3.0. Results and Discussion

3.1. Selected physical and chemical properties of the soil (0-20cm) soil depth.

The physical and chemical properties of the soil before application of amendments are shown in table 4.1. The soil is a sandy-loam with a total percent of sand as 71%, 19% silt, 10% clay. Some of the chemical components of the soil showed that N, P, K, Ca, Mg, Na and OC% in fertility. The pH is slightly acidic with a value of 5.8.

Table 1. Initial physical and chemical characteristics of the studied soil before planting

Soil properties	Values
Clay (%)	10
Silt (%)	19
Fine sand (%)	53
Coarse sand (%)	18
Texture class	Sandy loam
Organic carbon (%)	0.718
Total nitrogen (%)	0.112
pH (H_20)	5.8
Exchangeable bases (me/100g)	
Sodium (Na^+)	0.04
Calcium (Ca^{2+})	1.60
Potassium (K^+)	0.07
Magnesium (mg^{2+})	1.20
Catio Exchange Capacity (CEC) Cmol/kg^{-1}	13.20
Exchangeable Acidity (EA) Cmol/kg^{-1}	1.20
Available phosphorous (mg/kg)	7.46

3.2. Evaluation of different planting dates and manure sources on soil pH, total nitrogen and organic carbon.

The results (Table 2) showed that soil pH did not significantly ($p < 0.05$) vary between the two planting dates in both 2018 and 2019 cropping season. It was obtained that soil amendments significantly improved the soil pH in the two years of study. The results recorded that while poultry dropping amended plots recorded the highest significant ($p < 0.05$) values (6.13 and 6.68) in both 2018 and 2019 cropping season, respectively, the control plots gave the least mean values (5.37 and 5.33) of soil pH in both years. The results implied that soil pH responded positively to the amendments compare to the control plots. This could be attributed to the required level of temperature and moisture as well as the nutrient elements for the enhancement of the soil pH. This is in conformity with the work of Igbal *et al.* (2014) who reported pH increase following the application of organic manure. However, there was a significant interaction in 2019, with rice husk dust when applied in the month of June giving the best (6.83) significant interaction.

Total Nitrogen (TN) concentration was shown to vary significantly ($p < 0.05$) in relation to time of planting and soil amendments employed in the two years of study. It was obtained that TN was higher in the month of May than June in both years. This could be attributed to low temperature and soil moisture content in the month of May when the planting was made, which reduced the evaporation and leaching of the available total nitrogen (N) in the soil. Other studies have reported results in relation to rainfall and temperature effects on nitrogen content of the soil (Wan *et al.,* 2001). Nitrogen is easily lost from a system during an intense temperature, as it volatilizes at higher temperature (Fatubrain and Olojugba, 2014). The results (Table 2) indicated significant ($p < 0.05$) improvement on the total nitrogen in the two years of study by soil amendments with organic manure sources (poultry dropping and swine manure) giving higher (1.08 g/kg and 1.00 g/kg) values, respectively in 2019. This could be attributed to the gradual release of nitrogen by organic manure and its decomposition rate (Liu *et al.,* 2010).

Soil organic carbon was significantly ($p < 0.05$) improved higher in the month of June in both 2018 and 2019 study period (Table 2). The results revealed that soil amendments also significantly increased the soil organic carbon (SOC) pool within the two years of study. It was observed that, as poultry dropping and urea soil amendments increased the SOC higher (1.069 g/kg and 1.049 g/kg) in 2018, poultry dropping and rice husk dust did increase the SOC significantly ($p < 0.05$) higher (1.167 g/kg and 1.148 g/kg) respectively in 2019 study year. This is in conformity with the Bronick and Lal, (2005) who reported a direct relationship between organic matter application and the final soil organic carbon (SOC).

It was also obtained that interaction of planting dates and amendments did significantly ($p < 0.05$) improved the soil organic carbon in both 2018 and 2019 study year. Poultry dropping when applied in the month of June in 2018 significantly ($p < 0.05$) improved the SOC higher as against what happened in 2019 when rice husk dust applied in the same month of June significantly ($p < 0.05$) increased the SOC higher than other soil amendments used in the study.

Table 2. Evaluation of different planting dates and manure sources effects on soil pH, total nitrogen, and organic carbon

Amendments	2018			2019		
	May	June	Mean	May	June	Mean
	Soil pH					
CT	5.33	5.40	5.37	5.23	5.43	5.33
NPK	5.77	5.70	5.73	5.63	5.53	5.58
PD	6.00	6.27	6.13	6.60	6.77	6.68
RHD	5.73	5.83	5.78	6.13	6.83	6.48
SM	5.80	5.77	5.78	6.10	6.10	6.10
UREA	5.47	5.50	5.48	5.40	5.47	5.43
Mean	5.68	5.74	5.71	5.85	6.02	5.94
LSD $_{0.05}$ for planting dates			NS			NS
LSD $_{0.05}$ for amendments			0.1497			0.2119
LSD $_{0.05}$ for plant. dates x amendments			NS			0.3032
	Total nitrogen (g/kg)					
CT	0.70	0.74	0.72	0.86	0.75	0.80
NPK	1.27	0.61	0.94	1.01	0.71	0.86
PD	1.16	0.75	0.96	1.17	1.00	1.08
RHD	1.03	0.65	0.84	1.05	0.81	0.93
SM	1.03	0.65	0.84	1.03	0.95	1.00
UREA	0.45	0.65	0.55	0.84	0.73	0.79
Mean	0.94	0.67	0.806	1.00	0.82	0.91
LSD $_{0.05}$ for planting dates			0.1620			0.0149
LSD $_{0.05}$ for amendments			0.1296			0.1168
LSD $_{0.05}$ for plant. dates x amendments			0.1848			NS
	Soil organic carbon (g/kg)					
CT	0.329	0.881	0.605	0.427	0.782	0.604
NPK	0.522	1.095	0.809	0.867	1.088	0.978
PD	0.980	1.157	1.069	1.152	1.182	1.167
RHD	0.779	1.129	0.954	1.079	1.217	1.148
SM	0.886	1.015	0.950	0.917	1.071	0.994
UREA	1.050	1.047	1.049	1.094	1.078	1.086
Mean	0.758	1.054	0.906	0.923	1.070	0.996
LSD $_{0.05}$ for planting dates			0.1500			0.0495
LSD $_{0.05}$ for amendments			0.1021			0.0942
LSD $_{0.05}$ for plant. dates x amendments			0.1518			0.1235

MWD = mean weight diameter, CT = control, NPK = nitrogen, phosphorous & potassium, PD = poultry dropping, SM = swine manure,

3.3. Evaluation of planting dates and manure sources effect on soil mean weight diameter (MWD), bulk density and soil organic carbon stock/carbon sequestration

The mean weight diameter (MWD) indicated significantly ($p < 0.05$) higher in the month of June than in May. This could be attributed to the increased rainfall and temperature which leads to quick decomposition of the organic amendments and improvement on the soil aggregates. The higher mean weight diameter recorded in the month of June in both 2018 and 2019 (0.6839 and 0.6379), respectively, indicated increased macro-aggregates in the soil which can be attributed to increased leaching below 20 cm soil depth of most silt and clay materials on the topsoil.

This situation depicts an increased natural drainage in the studied soil within the periods of study. This could be good attributes for arable crops grown in the studied area as the soil will always be drained.

It was also obtained that soil amendments used gave significant ($p < 0.05$) variation on the MWD of the studied soil for 2018 and 2019 period of study with NPK amended soil found to have higher significant increase on the mean weight diameter (MWD) for the two years of study. Application of NPK in the month of June for 2018 and 2019 significantly increased MWD higher than other amendments applied in the same month and in the month of May.

Soil bulk density was significantly higher (1.71 and 1.68 Mg/m^2) in planting date of May in both 2018 and 2019 seasons, respectively. This shows that plots cultivated in June reduced the bulk density drastically lower than those cultivated in May, which could be attributed to variation in the environmental factor. The decrease in soil bulk density in the month of June could be related to increased aggregation as a result of higher level of MWD.

The results (Table 3) indicated that as swine manure significantly ($p < 0.05$) reduced (1.58 Mg/m^2) soil bulk density better in 2018, rice husk dust significantly deceased (1.51 Mg/m^2) the BD in 2019. The results showed that in the two years of study, control plots increased the soil bulk density higher than the amended plots. This is an indication that application of manure to cultivated soils increases organic carbon level, hence, reduced soil compaction and improvement in the total porosity of the soil. Bhattacharyya *et al.* (2007) showed that the use of amendment increased the organic carbon level of sandy loam soil which was related to a reduction in soil density and increase in aggregate stability.

Table 3 reveals that carbon sequestration varied significantly between soils cultivated in the month of May and June in both 2018 and 2019. It was obtained that areas cultivated in June significantly improved the carbon sequestration higher than areas cultivated in May. This could be as a result of increased moisture content of the soil which in turn increased soil organic carbon pool. As more productive croplands, Pan *et al.* (2004) reported that rice paddies generally have higher soil organic carbon (SOC) storage and sequestration capacity under fertilization

Table 3. Evaluation of planting dates and manure sources effect on soil mean weight diameter (MWD), bulk density and soil organic carbon stock/carbon sequestration

Amendments	2018			2019		
	May	June	Mean	May	June	Mean
	MWD					
CT	0.6286	0.6529	0.6407	0.6424	0.5967	0.6195
NPK	0.5397	1.1405	0.8401	0.5914	0.7859	0.6887
PD	0.5691	0.6810	0.6250	0.5613	0.6686	0.6149
RHD	0.4766	0.4739	0.4752	0.6169	0.5764	0.5967
SM	0.5750	0.5605	0.5678	0.5675	0.5961	0.5818
UREA	0.5186	0.5944	0.5565	0.5745	0.6038	0.5892
Mean	0.5513	0.6839	0.6176	0.5923	0.6379	0.6151
$LSD_{0.05}$ for planting dates			0.01845			0.03858
$LSD_{0.05}$ for amendments			0.03652			0.05986
$LSD_{0.05}$ for plant. dates x amendments			0.04782			0.07911
	Bulk density (g cm^{-3})					
CT	1.82	1.75	1.79	1.70	1.62	1.66
NPK	1.76	1.68	1.72	1.70	1.56	1.63
PD	1.67	1.59	1.63	1.67	1.43	1.55
RHD	1.63	1.56	1.60	1.50	1.51	1.51
SM	1.66	1.50	1.58	1.58	1.48	1.53
UREA	1.75	1.62	1.69	1.65	1.55	1.60
Mean	1.72	1.62	1.67	1.635	1.524	1.58
$LSD_{0.05}$ for planting dates			0.0778			0.0710
$LSD_{0.05}$ for amendments			0.0892			0.1066
$LSD_{0.05}$ for plant. dates x amendments			NS			NS
	Carbon sequestration (Kg m^{-2}) (kg m^{-2})					
CT	11.98	31.00	21.49	14.59	25.35	19.97
NPK	18.34	36.75	27.54	29.48	33.81	31.64
PD	32.59	36.97	34.78	38.55	34.05	36.30
RHD	25.36	35.23	30.29	32.47	36.70	34.58
SM	29.48	30.48	29.98	28.93	31.78	30.36
UREA	36.75	33.92	35.34	36.18	33.40	34.79
Mean	25.75	34.06	29.90	30.03	32.51	31.27
$LSD_{0.05}$ for planting dates			3.931			0.460
$LSD_{0.05}$ for amendments			4.315			4.149
$LSD_{0.05}$ for plant. dates x amendments			5.854			5.360

MWD = mean weight diameter, CT = control, NPK = nitrogen, phosphorous & potassium, PD = poultry dropping, SM = swine manure, LSD = least significant difference, NS = non-significant.

(Wang *et al.,* 2010) when compared to drier croplands. The results also showed variation in carbon sequestration due to amendments. In the first year (2018) of study, plots amended with Urea fertilizer improved the sequestration of the carbon higher, followed by poultry dropping treated plots. In the 2nd year (2019), poultry dropping treated plots significantly improved the sequestration of the soil carbon more, followed by rice husk dust and urea fertilizer amended plots.

3.4. Evaluation of planting date and manure sources effect on soybean yield (t/ha)

The results (Table 4) showed significant ($P<0.05$) improvement on soybean pod weight by the planting dates used in the two years of study. It was recorded that plots cultivated in May increased the pod yield (7.21 t/ha) over the one planted in June (5.54 t/ha) in 2018. More so, in 2019 plots cultivated in May significantly increased the soybean pod weight yield by 2.28 t/ha difference over the pod weight yield recorded in the planting made in June 2019. These differences among the two different months of study (May and June) might have been due to varying environmental factors. Environmental factors, especially temperature and rainfall during the period of seed development and maturation, might have affected the yield and yield components. In this regard, the maximum weight yield of pod was observed in the plants that were planted in May, which progressively decreases as rainfall increased. The present study showed that when the temperature and rainfall increased towards the maturity of the plant, the biological and seed yield decreased. Rahman *et al.,* (2005) reported that soybean yield decreased due to changes in sowing dates which related to the environmental conditions mostly observed during the plant life cycle.

Soil amendments also significantly ($p < 0.05$) varied the pod weight yield for the two years (2018 and 2019). It was shown that, as urea fertilizer amended plots significantly ($P<0.05$) increased the pod yield weight (6.97 t/ha) higher in 2018, poultry dropping treated plots gave higher significant improvement on the pod yield weight (7.39 t/ha) in 2019 cropping season. Generally, the least pod yield weight (5.88 t/ha and 6.15 t/ha) in both 2018 and 2019, respectively, was recorded in the control plots. On the other hand, the interaction of the planting dates and the amendments indicated also significant ($p < 0.05$) effect on the soybean pod weight at harvest with NPK amended plots in the month of May in 2018 recording the highest pod weight, while in 2019, poultry dropping amended plots in the month of May did increase the pod weight significantly higher.

Table 4 indicated that the grain yield weight was varied significantly in the two years of study due to differences in planting dates. The grain yield variation followed the trend of pod weight yield. It was found that plants cultivated in May produced significant higher grain yield (4.48 t/ha and 4.72 t/ha) in both 2018 and 2019 cropping season, respectively over the ones cultivated in the month of June for the two years (2018 and 2019). This implied that soybean planted during the early part of the year passes and complete their life cycle taking longer period, and they had higher grain weight, while the soybean planted during June had higher temperature during the early phases and complete their cycle rapidly, hence, lower grain weight. The result is in agreement with the findings of Yajam and Mandani (2013) who observed that grain weight was significantly affected by planting dates. The grain yield is the function of combined effect of all the yield components under the influence of a particular set of environmental conditions. The grain yield decrease little by little with delay in planting date.

Results (Table 4) indicated that amendments significantly improved the soybean grain yield with poultry dropping increasing the grain yield weight (3.83 t/ha and 4.23 t/ha) significantly ($p < 0.05$) higher in both 2018 and 2019 crop-

Table 4. Evaluation of planting dates and manure sources effect on soybean yield (tons/ha)

Amendments	2018			2019		
	May	June	Mean	May	June	Mean
Pod weight yield (ton/ha)						
CT	6.07	5.69	5.88	6.23	6.07	6.15
NPK	8.09	4.70	6.40	8.76	4.96	6.86
PD	7.24	5.83	6.54	8.77	6.00	7.39
RHD	6.93	5.17	6.05	7.84	5.27	6.56
SM	7.01	5.82	6.41	7.79	5.86	6.82
UREA	7.91	6.02	6.97	8.39	5.93	7.16
Mean	7.21	5.54	6.37	7.96	5.68	6.82
$LSD_{0.05}$ for planting dates			1.3212			1.1087
$LSD_{0.05}$ for amendments			0.5632			0.5194
$LSD_{0.05}$ for plant. dates x amendments			1.0511			0.9119
Grain yield weight (tons/ha)						
CT	4.19	2.04	3.11	4.19	2.67	3.43
NPK	4.94	2.43	3.68	5.07	3.02	4.05
PD	4.60	3.05	3.83	5.08	3.38	4.23
RHD	3.58	2.45	3.01	4.08	3.11	3.60
SM	4.56	2.87	3.71	4.89	3.18	4.04
UREA	5.02	2.56	3.79	5.04	2.85	3.95
Mean	4.48	2.57	3.52	4.72	3.04	3.88
$LSD_{0.05}$ for planting dates			0.2314			0.4297
$LSD_{0.05}$ for amendments			0.2981			0.5158
$LSD_{0.05}$ for plant. dates x amendments			0.3985			NS

MWD = mean weight diameter, CT = control, NPK = nitrogen, phosphorous & potassium, PD = poultry dropping, SM = swine manure, LSD = least significant difference, NS = non-significant.

ping season, respectively, over other amendments in the study.

4.0 Conclusion

The study revealed that planting date is an important factor affecting both soil properties and soybean development in the study area. Generally, early planting time (May) gave higher soybean yield with less improvement on some soil properties as pH, soil carbon stock and mean weight diameter.

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