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EFFECT OF POULTRY MANURE AND P SOLUTION CONCENTRATIONS ON THE YIELD OF SOYBEANS IN SOME SOILS OF BENUE STATE – NIGERIA

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ABSTRACT

A pot experiment was conducted at the Teaching and Research Farm of the University of Agriculture Makurdi - Nigeria using soils collected from 6 locations (Daudu, Ayati, TseAgbakor, TseKough, Ayange, and Mbachor) to determine the effect of poultry manure and P solution concentrations on the yield of soybeans. Six levels of P solution concentration (0, 0.150, 0.175, 0.20, 0.225, 0.250 mg l^{-1}) 2 levels of poultry manure (0 and 6 t ha^{-1}) and six soils factorially combined constituted the experimental treatments. Four Kg of the soils were weighed into perforated plastic pots of 5 liters capacity and the treatments applied accordingly. Each pot received an initial application of 60 kg N ha^{-1} as urea, and 30 kg K ha^{-1} in the form of KCl as basal application and the pots were arranged in a Completely Randomized Design (CRD) with three replications. Three soybean seeds of the variety TGX 1935-3F were planted per pot and later thinned to 2 at two weeks after planting. The crops were grown to maturity and all agronomic practices carried out as at when necessary. Data collected were subjected to the analysis of variance. Results indicate that the soils under study had low to moderate levels of available P. The addition of Poultry manure contributed significantly to the yield of the crop. P solution concentration for optimal soybeans production on these soils varied from 0.175 mg l^{-1} at Ayati and Ayange to 0.225 mg l^{-1} at TseKough. For Daudu, TseAgbakor and Mbachor it was 0.200 mg l^{-1}.

Keywords: Poultry Manure, Alfisols, Inceptisols, Solution Concentration, Phosphorus

Introduction

Phosphorus (P) is one of the essential elements for plant growth, the total quantity of P in most native soils is low with most of what is present unavailable to plants (Brady and Weil, 2014). Adequate phosphorus results in higher grain production, improved crop quality, greater stalk strength, increased root growth and earlier crop maturity as it enhances the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting and maturation (Brady and Weil, 2014). Warren (1992) stated that phosphorus deficiency is one of the largest constraints to food production in tropical African soils due to low native P and high fixation by iron and aluminum oxides. It has also been reported that phosphorus is relatively unavailable for plant uptake in highly weathered tropical soils (Iyamuremye *et al.*, 1996). In order to meet the crop need of phosphorus in these soils, farmers make use of inorganic fertilizers for their crops. However, P fertilizer is not readily available to these farmers because of scarcity in some cases and also due to the high cost of these fertilizers.

Poultry manure has long been recognized as the most desirable organic fertilizer. It improves soil fertility by adding both major and essential nutrients as well as soil organic matter which improve moisture and nutrient retention (Farhad *et al*., 2009). Poultry manure may be used for crop production as a substitute for the chemical fertilizers because; continuous use of chemical fertilizers creates potential polluting effect in the environment (Oad *et al*., 2004) and because of their high cost of production. However, the use of organic manure without chemical fertilizers seems to be impossible because of the growing demand for food necessitated by the growing world population.

The present study therefore was carried out to determine the effect of poultry manure and solution P concentrations on the yield of soybean.

MATERIALS AND METHODS

Surface soil samples (0 - 20 cm) were collected from six different locations in Benue State (Daudu, Ayati, TseAgbakor, TseKough, Ayange, and Mbachor); these soils were earlier classified as Alfisols and Inceptisols (Table 1). Poultry manure was sourced from the University of Agriculture Makurdi Livestock Teaching and Research Farm.

Routine Analysis

The collected soil samples were air-dried and ground to pass through 2mm sieve. Soil pH was determined in a 1:1 soil-water suspension by the glass electrode method, particle size analysis by the hydrometer method of Bouyoucos (1951). Total organic carbon by the chromic acid oxidation procedure of Walkley and Black (1934), exchangeable bases by the neutral ammonium acetate saturation. Na and K in the extracts were determined by the flame photometer while Ca and Mg were determined with the Atomic Absorption Spectrophotometer (AAS), exchange acidity by the 1M KCl extraction and 0.01M NaOH titration. Nitrogen in the samples was determined by the Marco Kjeldahl method, Free Fe and Al oxides (Total oxides) were extracted by the citrate dithionate – bicarbonate method (Mebra and Jackson, 1960). Iron and Aluminum oxides in the extracts were determined with an Atomic Absorption Spectrophotometer (AAS).

A sample of the poultry manure used in the experiment was air dried and ground to pass 2 mm sieve. The ground poultry manure sample was analyzed for N using the Marco Kjeldal method of Isaac and Johnson and total P by the NaOH digestion method (Mehra *et al.,* 1954). Ca and Mg were determined using Atomic Absorption Spectrophotometer (AAS) while K and Na was determined using flame photometer.

Table 1: Soil Classification of the Study Sites

S/N	Location	GPS Coordinates	Soil Class
1	Daudu	N 7^0 55.06’, E 8^0 35.74’	TypicPaleustalf (USDA) OrthicLuvisol (FAO)

2	TseKough	N 7^0 28.83', E 8^0 37.35'	TypicHaplustalf (USDA) OrthicLuvisol (FAO)
3	Ayange	N 7^0 20.00', E 8^0 34.00'	Aquichaplustalf (USDA) Orthicluvisol (FAO)
4	TseAgbakor	N 7^0 27.94', E 8^0 35.73'	TypicTropaquept (USDA) GleyicCambisol (FAO)
5	Mbachor	N 7^0 17.80', E8^0 29.18'	OxicUstropept (USDA) EutricCambisol (FAO)
6	Ayati	N 7^0 56.68', E 8^0 34.84'	OxicUstropept (USDA) EutricCambisol (FAO)

Pot Experiment

A pot experiment was conducted at the Teaching and Research Farm of the University of Agriculture Makurdi using soils collected from six locations (Daudu, Ayati, TseAgbakor, TseKough, Ayange, and Mbachor). Six levels of Phosphate solution concentrations (0, 0.150, 0.175, 0.20, 0.225, 0.250 mg l^{-1}), 2 levels of poultry manure (0 and 6 t ha^{-1}) and six soils factorially combined constituted the experimental treatments (Table 2) and were arranged in a Completely Randomized Design (CRD) with three replications.

Four (4) Kg of the soils were weighed into perforated plastic pots of 5litres capacity in two sets. Phosphorus was added in the form of K_2HPO_4 at different rates equivalent to 0, 0.150, 0.175, 0.20, 0.225, 0.250 mg l^{-1} to the plastic pots. One set of the soils in addition to the added Phosphorus fertilizer received additions of poultry manure at the rate of 6 t ha^{-1} and the other set left without poultry manure addition. Each pot received an initial application of 60 Kg N ha^{-1} as urea, and 30 Kg K ha^{-1} as KCl (Yusuf and Idowu, 2001)

Three soybean seeds of the variety TGX 1935-3F (test crop) was planted per pot and later thinned to 2 two weeks after planting. The crops were grown to maturity and all agronomic practices were carried out as at when necessary.

Table 2: Experimental Treatments

Soil Location	Poultry Manure (t ha^{-1})	Fertilizer P solution concentration (mg l^{-1})	Soil Location	Poultry Manure (t ha^{-1})	Fertilizer P solution concentration (mg l^{-1})
Daudu	0	0.000	TseAgbakor	0	0.000
		0.150			0.150
		0.175			0.175
		0.200			0.200
		0.225			0.225
		0.250			0.250
	6	0.000		6	0.000

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		0.150			0.150
		0.175			0.175
		0.200			0.200
		0.225			0.225
		0.250			0.250
TseKough	0	0.000	Mbachor	0	0.000
		0.150			0.150
		0.175			0.175
		0.200			0.200
		0.225			0.225
		0.250			0.250
	6	0.000		6	0.000
		0.150			0.150
		0.175			0.175
		0.200			0.200
		0.225			0.225
		0.250			0.250
Ayange	0	0.000	Ayati	0	0.000
		0.150			0.150
		0.175			0.175
		0.200			0.200
		0.225			0.225
		0.250			0.250
	6	0.000		6	0.000
		0.150			0.150
		0.175			0.175
		0.200			0.200
		0.225			0.225
		0.250			0.250

Data Collection and Statistical Analysis

Agronomic data collected include number of pods per plant, number of seeds per pod, 100 pod weight, 100 grain weight and grain yield at harvest. These were subjected to the analysis of variance (ANOVA) using Genstat Discovery Edition 4 at 5 % level of probability. Where significant differences among means were observed, Least Significant Difference (LSD) was used to separate means.

RESULTS

Physical and Chemical Properties of the Experimental Soils

Some selected properties of the experimental soils are presented on Table 3. pH (H_2O) values ranged from 5.00 at Daudu to 6.86 at Mbachor indicating that the soils are acid to slightly acidic.

Clay content varied from 122 g kg^{-1} at Mbachor to 173.20 g kg^{-1}at Daudu. The six experimental soils were all sandy loam in texture. Organic matter content varied from 13.8 g kg^{-1}at Ayati (the least) to 16.40 g kg^{-1}at Daudu which had the highest organic matter content. Fe_2O_3 ranged from 4.00 g kg^{-1}at TseAgbakor to 19.00 g kg^{-1} at Daudu. Ayati had the least Al_2O_3 content (7.00 g kg^{-1}) while Ayange soils had the highest value (12.00 g kg^{-1}). Available P values ranged from 5.20 mg kg^{-1} at TseKough to 12.50 mg kg^{-1} at TseAgbakor. Daudu had 6.01 mg kg^{-1}, Ayange 7.21 mg kg^{-1}, Mbachor 12.42 mg kg^{-1} while Ayati had 8.20 mg kg^{-1}. Results also showed that cation exchange capacity (CEC) varied from 5.40 cmol kg^{-1} at Mbachor to 6.22 cmol kg^{-1}at Daudu.

Properties of the Poultry Manure

Selected properties of the poultry manure used in the experiment are presented on Table 4. Results indicate that the pH of the manure is near neutral and has appreciable amount of organic carbon content with Calcium been the most abundant (7.40 %) of the exchangeable cations.

Table 3: Physical and Chemical Properties of the Experimental Soils

Soil property	Daudu	TseKough	Ayange	TseAgbakor	Mbachor	Ayati
pH H_2O (1:1)	5.00	5.98	5.68	6.50	6.86	6.47
Sand (g kg^{-1})	695	730	726	766	765	733
Silt (g kg^{-1})	131.8	131	124	102	113	130
Clay (g kg^{-1})	173.2	139	150	132	122	137
Textural class	SL	SL	SL	SL	SL	SL
Organic C (g kg^{-1})	9.5	9.3	9.0	8.3	8.7	8.0
Org matter (g kg^{-1})	16.4	16.1	15.6	14.4	15.1	13.8
N (%)	0.09	0.10	0.09	0.08	0.07	0.08
Available P (mg kg^{-1})	6.01	5.20	7.21	12.50	12.42	8.20
Ca (cmol kg^{-1})	3.75	3.57	3.85	3.07	2.77	2.84
Mg (cmol kg^{-1})	1.50	1.54	1.40	1.37	1.30	1.28
K (cmol kg^{-1})	0.27	0.29	0.26	0.25	0.24	0.23
Na (cmol kg^{-1})	0.69	0.58	0.60	0.48	0.55	0.56
CEC (cmol kg^{-1})	6.22	6.20	6.52	5.90	5.40	5.73
B.S (%)	99.84	96.45	93.71	87.63	90.00	85.69
Exch A.	0.02	0.02	0.02	0.01	0.02	0.01
Fe_2O_3 (g kg^{-1})	19.0	12.0	8.0	4.0	6.0	5.0
Al_2O_3 (g kg^{-1})	11.0	10.0	12.0	8.0	9.0	7.0

*SL = Sandy Loam

Table 4: Properties of the Poultry Manure used in the Experiment

Parameter	Value
pH (1:1)	6.80
N (g kg^{-1})	50.2
P (mg kg^{-1})	5.00
K (cmol kg^{-1})	0.90
Ca (cmol kg^{-1})	7.40
Mg (cmol kg^{-1})	0.52
Na (cmol kg^{-1})	0.98
Org C. (g kg^{-1})	121.0

Effect of Fertilizer P Solution Concentration on the Yield of Soybeans

The effect of solution P concentrations on the yield of soybean is presented in Table 5. Significant differences were observed in all the variates studied. It was observed that the number of pods produced per plant increased with increasing levels of P concentration in solution and later declined. 0.00 mg P kg^{-1} yielded 27.33 numbers of pods while solution P concentration of 0.200 mg P kg^{-1} gave the highest value (92.58) in terms of number of pods produced. Numbers of pods produced at each P solution concentration were significantly ($P < 0.05$) different.

Significant differences were observed in the number of seeds per pod. 0.225 mg kg^{-1} gave the highest numbers of seed (2.80) per pod which was significantly higher than those of the other treatments. However, no significant differences were observed when the number of seeds per pod of the control (0.00 mg P kg^{-1}), 0.150 mg kg^{-1} and 0.175 mg kg^{-1} were compared.

Results for 100 pod weight (Table 5) shows that 0.200 mg P kg^{-1} solution concentration gave the highest weight (35.98 g) per 100 pods which was significantly ($P< 0.05$) higher than those of other treatments. The control (0.00 mg kg^{-1}) had the least weight per 100 pods (30.47 g)

Significant differences were obtained in the 100 grain weight of soybeans at the various solution P concentrations (Table 5) with 0.200 mg kg^{-1} giving the highest weight (14.41 g)which was significantly ($P < 0.05$) higher than the other treatments. There was however, no significant difference between the 100 grain weights obtained with 0.150 mg kg^{-1} and 0.175 mg kg^{-1} P respectively.

Results similar to that of 100 grain weight were observed with the grain yield (t ha^{-1}) with 0.200 mg kg^{-1} yielding significantly ($P < 0.05$) higher than the other P solution concentrations with grain yield of 3.02 t ha^{-1}.

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Table 5: Effect of Fertilizer P Solution Concentration on the Yield of Soybeans

Fert P conc (mg kg^{-1})	Number of pods/plant	Number of seeds/pod	100 pod weight (g)	100grain weight (g)	Grain yield (t ha^{-1})
0.000	27.33	1.97	30.47	11.24	2.02
0.150	34.44	1.99	28.81	12.03	2.25
0.175	41.61	2.01	31.52	12.31	2.47
0.200	92.58	2.10	35.98	14.41	3.02
0.225	71.42	2.80	33.89	13.35	2.68
0.250	51.25	2.20	32.37	12.73	2.85
LSD (0.05)	6.106	0.05012	1.433	0.6145	0.1510

Effect of Poultry Manure on the Yield of Soybean

Results on Table 6 indicate that poultry manure addition had no significant effect on the number of seeds per pod and 100 pod weight of soybeans. However, significant differences were observed in number of pods per plant where poultry manure addition raised the number of pods produced per plant from 48.19 to 58.02, and 100 grain weight which increased from 12.50 g to 12.85 g. poultry manure addition raised the grain yield significantly from 2.51 t ha^{-1} without poultry manure addition to 2.59 t ha^{-1} upon poultry manure addition.

Table 6: Effect of Poultry Manure on the Yield of Soybeans

Poultry manure (t ha^{-1})	Number of pods/plant	Number of seeds/pod	100 pod weight (g)	100 grain weight (g)	Grain yield (t ha^{-1})
0	48.19	2.10	32.01	12.50	2.51
6	58.02	2.09	32.34	12.85	2.59
LSD (0.05)	3.525	NS	NS	0.35	0.08

Effect of Soil Location on the Yield of Soybeans

Results shown on Table 7 indicate significant differences in all the variates studied across the different soils with the exception of number of seeds per pod. Number of pods per plant ranged from 46.33 at Ayange to 59.11 at Mbachor. Number of pods per plant produced by soils from TseAgbakor (55.92), Mbachor (59.11), Ayati (56.56) and Daudu (53.72) were significantly higher than those of TseKough (47.00) and Ayange (46.33). However, no significant differences were observed in-between them.

One hundred pod weight showed that soils from Daudu had the highest weight (34.82 g) this was however not significantly different from the weight obtained at Mbachor (33.61 g) Ayange had the least 100 pod weight (29.21 g) while 100 pod weight obtained from Agbakor (31.47 g) and Ayati (31.00 g) did not vary significantly ($P < 0.05$) from each other.

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Significant differences were obtained in the 100 grain weight with Ayange (13.39), TseAgbakor (13.52) and Mbachor (13.08) having significantly higher 100 grain weight than the other soils though no significant difference was observed among these three soils.

In terms of grain yield (t ha^{-1}), results contained in Table 7 showed TseAgbakor to have performed significantly ($P < 0.05$) better than soils from other locations. The yield values varied from 2.23 t ha^{-1} at TseKough to 2.83 t ha^{-1} at TseAgbakor.

Table 7: Effects of Soil Location on the Yield of Soybeans

Location	Number of pods/plant	Number of seeds/pod	100 pod weight (g)	100 seed weight (g)	Grain yield (t ha^{-1})
Daudu	53.72	2.09	34.82	12.33	2.29
TseKough	47.00	2.12	32.92	10.91	2.23
Ayange	46.33	2.08	29.21	13.39	2.51
TseAgbakor	55.92	2.12	31.47	13.52	2.83
Mbachor	59.11	2.08	33.61	13.08	2.78
Ayati	56.56	2.08	31.00	12.84	2.66
LSD (0.05)	6.106	NS	1.433	0.6145	0.1510

Integrated Effect of Fertilizer P Solution Concentration and Poultry Manure on the Yield of Soybean

Table 8 contains results of the integrated effect of poultry manure and fertilizer P concentration on the yield of soybeans. The addition of poultry manure enhanced though not significantly the performance of the crop in most of the variates studied. Significant differences were however observed in the number of pods produced per plant where at a solution P concentration of 0.150 mg kg^{-1} addition of poultry manure significantly raised the number of pods produced per plant from 29.78 to 39.11 and from 87.56 to 97.61 at 0.200 mg kg^{-1}. However, even with the addition of poultry manure, the number of pods produced per plant decreased significantly at levels of P concentration beyond 0.200 mg kg^{-1}.

Table 8: Integrated Effect of Poultry Manure and Fertilizer P solution concentration on the Yield of Soybean

Poultry Manure	Fert P conc (mg kg^{-1})	Number of pods/plant	Number of seeds/pod	100 pod weight (g)	100 grain weight (g)	Grain yield (t ha^{-1})
0	0.000	24.39	1.96	28.63	11.04	2.13
	0.150	29.78	2.00	30.29	11.77	2.32
	0.175	64.56	2.30	31.43	14.18	2.49
	0.200	87.56	2.13	36.19	12.60	3.08

	0.225	45.56	2.24	33.51	13.33	2.84
	0.250	37.33	2.00	31.98	12.09	2.70
6	0.000	30.28	2.00	28.98	11.44	1.91
	0.150	39.11	2.00	30.65	12.28	2.18
	0.175	78.28	2.27	31.62	14.64	2.87
	0.200	97.61	2.07	35.77	12.86	2.97
	0.225	56.94	2.16	34.26	13.37	2.44
	0.250	45.89	2.03	32.75	12.53	2.66
LSD	(0.05)	8.635	NS	NS	NS	NS

Integrated Effect of Poultry Manure and Soil Location on Soybean Yield

Significant differences were observed in the integrated effects of poultry manure and soil location on the yield of soybeans with regards to most of the variates studied (Table 9). With the addition of poultry manure to the Daudu soils, the 100 pod weights and grain yield increased significantly ($P < 0.05$) from 33.67 g and 2.10 t ha^{-1} to 35.98 g and 2.48 t ha^{-1} respectively. The different soils upon poultry manure addition performed significantly ($P < 0.05$) better in most of the parameters studied. Also, TseAgbakor had significantly ($P < 0.05$) higher number of pods (72) than the other soils however, no significant differences were observed among the other variates.

Integrated Effect of Fertilizer P and Soil Location on Yield of Soybeans

The effects of P solution concentration and soil location on the yield of soybean are shown on Table 10. Number of pods produced per plant in the Daudu soil increased significantly with increase in solution P concentration up to 0.200 mg kg^{-1} (91.50) and decreased thereafter. Similar trends were observed with number of seeds per pod, 100 pod weight, 100 grain weight and grain yield though no significant differences were observed in these variates. The highest grain yield (2.60 t ha^{-1}) was obtained with 0.200 mg kg^{-1} P consequently; the quantity of fertilizer P required to achieve this level of solution P concentration in this soil was calculated as 1.60 mg kg^{-1} soil. This is equivalent to 204.18 kg ha^{-1} and was therefore taken as the SPR value for the Daudu soil.

Table 9: Integrated Effect of Poultry manure and Soil on the yield of soybean

Poultry Manure	Soil Location	Number of pods/plant	Number of seeds/pod	100 pod weight (g)	100 seed weight (g)	Grain yield (t ha^{-1})
0	Daudu	50.89	2.09	33.67	11.92	2.10
	TseKough	41.61	2.12	30.34	13.10	2.15
	Ayange	39.56	2.12	28.44	13.08	2.49
	TseAgbakor	39.83	2.11	28.73	10.33	2.52
	Mbachor	61.28	2.07	33.51	13.09	2.87
	Ayati	56.00	2.11	30.63	12.61	2.52
6	Daudu	56.56	2.11	35.98	12.75	2.48

	TseKough	52.39	2.10	35.51	13.98	2.30
	Ayange	53.11	2.05	29.99	13.69	2.52
	TseAgbakor	72.00	2.14	34.20	11.48	2.79
	Mbachor	56.94	2.08	33.71	13.07	3.04
	Ayati	57.11	2.05	31.37	13.08	2.80
LSD	(0.05)	8.635	0.0708	2.027	0.8690	0.2136

Table 10: Effect of Fertilizer P Solution Concentration and Soil on the Yield of Soybeans

Soils	Fert P conc (mg kg^{-1})	Number of pods/plant	Number of seeds/pod	100 pod weight (g)	100 grain weight (g)	Grain yield (t ha^{-1})
Daudu	0.000	28.50	2.02	31.59	11.12	1.88
	0.150	35.17	2.00	32.63	11.83	2.07
	0.175	42.67	2.02	33.79	12.08	2.31
	0.200	91.50	2.20	39.32	13.38	2.60
	0.225	73.80	2.22	36.55	12.78	2.41
	0.250	50.67	2.14	35.07	12.35	2.48
TseKough	0.000	25.67	2.00	29.05	12.00	1.73
	0.150	38.83	2.00	31.30	12.93	1.93
	0.175	42.00	2.00	32.20	13.18	2.08
	0.200	47.83	2.00	32.63	13.50	2.28
	0.225	70.67	2.35	38.08	14.93	2.85
	0.250	57.00	2.30	34.28	14.57	2.48
Ayange	0.000	32.00	2.00	25.98	11.90	1.69
	0.150	45.67	2.00	27.68	12.67	2.13
	0.175	81.17	2.00	32.13	15.38	3.19
	0.200	53.67	2.05	29.62	13.98	2.65
	0.225	39.17	2.30	31.00	13.40	2.95
	0.250	26.33	2.15	32.13	12.98	2.43
TseAgbakor	0.000	29.50	1.94	28.85	9.85	2.31
	0.150	32.00	1.98	30.30	10.70	2.50
	0.175	43.50	2.32	30.60	10.70	2.75
	0.200	97.00	2.22	33.95	12.10	3.33
	0.225	83.00	2.25	33.05	11.10	3.12
	0.250	50.00	2.05	31.80	11.00	2.98
Mbachor	0.000	22.33	1.92	30.06	11.81	2.23
	0.150	32.33	2.00	32.15	12.37	2.46
	0.175	42.50	2.00	32.60	12.62	2.67
	0.200	96.17	2.05	37.38	14.92	3.28
	0.225	90.00	2.30	35.98	13.85	3.10
	0.250	61.33	2.20	33.46	12.91	2.98

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Ayati	0.000	26.33	1.98	27.04	10.77	2.27
	0.150	32.00	2.00	28.78	11.65	2.40
	0.175	81.17	2.00	35.01	15.29	3.02
	0.200	53.67	2.30	31.61	13.80	2.79
	0.225	39.17	2.10	32.47	13.21	2.92
	0.250	45.67	2.10	31.10	12.33	2.57
LSD	(0.05)	14.956	NS	NS	1.5051	0.3700

The effects of P solution concentration and soil location on the yield of soybean in TseKough soil (Table 10) shows that the number of pods per plant, number of seeds per pod, 100 pod weight, 100 seed weight and grain yield increased significantly with increase in solution P concentration up to 0.225 mg kg^{-1} attaining the highest grain yield (2.85 t ha^{-1}) at this level. This solution concentration therefore appears to be the optimum solution P concentration for soybean on this soil. Consequently the quantity of fertilizer P required to achieve this level of solution concentration was calculated to be 1.75 mg kg^{-1} therefore this value was taken to be the standard phosphate requirement for the TseKough soil which is equivalent to 223.32 kg P ha^{-1}

Similar results as with the other Alfisols were obtained with the Ayange soil (Table 10). Values of all the variates increased with increasing solution P concentration up to 0.175 mg kg^{-1} before declining. The maximum grain yield (3.19 t ha^{-1}) was obtained at 0.175 mg kg^{-1} P solution concentration and was therefore taken to be the optimum SPC for this soil. Consequently the amount of fertilizer P needed to attain this concentration was calculated to be 1.07 mg kg^{-1}which is equivalent to 136.55 kg P ha^{-1} and taken to be the SPR for the Ayange soil

TseAgbakor obtained the highest values of number of pods produced per plant (97), 100 pod weight (33.95 g), 100 seed weight (12.10 g), and grain yield (3.33 t ha^{-1}) at solution concentration of 0.200 mg kg^{-1}. Therefore 0.200 mg kg^{-1}P solution concentration was taken to be the optimum concentration for the TseAgbakor soil. The amount of fertilizer P required to achieve this solution concentration was calculated to be 0.8 mg kg^{-1} (SPR). This is equivalent to 102.09 kg P ha^{-1}

The Mbachor soil, an Inceptisol had the highest grain yield value of 3.28 t ha^{-1} at a solution concentration of 0.200 mg kg^{-1}therefore this solution concentration was taken to be the optimum SPC and the amount of fertilizer P needed to attain the solution concentration was calculated to be 0.47 g kg^{-1} soil which is an equivalent of 59.98 kg P ha^{-1} and was therefore taken to be the SPR for the Mbachor soil.

There was response of soybean to fertilizer P applications in the Ayati soil as the concentration of solution P was increased. The highest number of pods produced per plant (81.17), 100 pods weight (35.01 g), 100 seed weight (15.29 g) and grain yield (3.02 t/ha) were obtained at a solution P concentration of 0.175 mg kg^{-1} consequently this solution concentration level is taken to be the optimum solution P concentration for soybean on this soil. The quantity of fertilizer P needed to achieve this solution concentration was calculated to be 0.34 g kg^{-1} soil which is

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equivalent to 43.39 kg P ha^{-1} and taken to be the standard phosphate requirement for the Ayati soil.

DISCUSSION

The properties of the soils indicate that the soils are acid to slightly acid with the Alfisols having more acidic tendency than the Inceptisols. The soils were generally low in Potassium, organic carbon content and total Nitrogen content this may be due to the practice of slash and burn which is still very common in the state and the seasonal indiscriminate burning of vegetation by wild fires as reported by (Anjembe, 2004) which prevents the formation of organic matter which is also the store house of most nutrients. The results agrees with the observation of Aduayi *et al.*, (2002) that most Nigerian soils are deficient in nitrogen, phosphorus and potassium, where for this elements less than 1.5 g kg^{-1} Total N, less than 8 mg kg^{-1} (Bray- 1 P) and less than 0.20 C mol kg^{-1} K are considered respectively to be below critical levels. Available P in the soils was low in the Alfisols (5.20 – 7.21 mg kg^{-1}) and of moderate values in the Inceptisols (8.20 – 12.50 mg kg^{-1}). Generally the Alfisols had more clay, Fe_2O_3, and Al_2O_3 content with average values of 154.1g kg^{-1}, 13.0 g kg^{-1} and 11.0 g kg^{-1} respectively as against 130.3 g kg^{-1}5.0 g kg^{-1} and 8.0 g kg^{-1} average values for the Inceptisols. This may have been responsible for the differences observed in their sorption behaviour.

The main effects of fertilizer P on the yield of soybeans indicated that solution concentration of 0.200 mg l^{-1} P resulted in optimum yield of the crops. This is the quilibrium soil solution concentration that has been suggested for obtaining 95% of the maximum yield of soybean (Fox, 1981). This result is however contrary to the reports of Anjembe (2012) who obtained optimum yield of soybean with lesser solution concentrations.

Observing the yield performances of the different soils, it could be seen that the soils performed differently in the different variates studied, the number of pods per plant was highest in the Mbachor soil, Daudu soil had the highest pod weight while TseAgbakor performed the best in terms of 100 grain weight and total grain weight (t ha^{-1}). This results may be attributed to the variance in some physical and chemical properties of the soils and as well as their adsorption and buffering capacities. It could also be traced to the initial p concentrations of these soils as TseAgbakor had the highest value of available P followed by the Mbachor soil.

Effect of poultry manure on the yield of soybeans (Table 9) revealed that additions of poultry manure did not affect significantly some of the parameters studied. However, the number of pods per plant and the total grain yield were increased significantly. This could be ascribed to the beneficial effects of poultry manure on the chemical, physical and biological properties of the soil. Most of these effects are due to an increase in soil organic matter (Shirani *et al.*, 2002; Liang *et al.*, 2011; Bakayoko *et al.*, 2009) resulting from manure application. Previous studies also revealed that Organic matter is an ion exchanger and has a net negative charge (Parfitt, 1990). They block sites on which phosphate could sorb. Wandruszka (2006) revealed that manure not only affects sorption and precipitation of P, but often contains significant amounts of the element which are thereby deliberately or incidentally added to the soil alongside other nutrient elements such as N, K and Ca.

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CONCLUSION

The soils under study had low to moderate levels of available P. The addition of Poultry manure contributed significantly to the yield of the crop. Fertilizer P solution concentration for optimal soybeans production on these soils varied from 0.175 mg l^{-1} at Ayati and Ayange to 0.225 mg l^{-1} at TseKough. For Daudu, TseAgbakor and Mbachor it was 0.200 mg l^{-1}.

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