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PERFORMANCE OF SOYBEAN (*Glycine max L.*) INFLUENCED BY DIFFERENT RATES AND SOURCES OF PHOSPHORUS FERTILIZER IN SOUTH-WEST NIGERIA

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ABSTRACT

Low yields of soybean in Nigeria are attributed to many factors such as declining soil fertility and use of low yielding soybean varieties. Phosphorus is a soybean plant growth-limiting nutrient.Therefore, application of phosphorus fertilizer at optimum level is essential. Two experiments were carried out at Ibadan, Nigeria to estimate the optimum P-fertilizer rate for soybean and to investigate the response of soybean to different sources of P fertilizer applied at the optimum rate. The treatments in the first experiment were two soybean varieties (TGX1987-10F and TGX1987-62F) and single superphosphate (SSP) fertilizer applied at five rates: 0kgPha^{-1}, 20kgPha^{-1}, 40kgPha^{-1}, 60kgPha^{-1} and 80kgPha^{-1}. The treatments in the second experiment were: SSP, *Tithonia* compost (TC), poultry manure (PM), TC+PM, SSP+TC, SSP+PM applied at optimum P (40kgPha^{-1})rate obtained from Experiment 1and control. Data collected on morphological parameters, grain yield (GY) and nutrient uptake were subjected to analysis of variance, the means were separated using least significant difference ($p \leq 0.05$). Results showed that TGX1987-62F (1.96Mgha^{-1}) produced significantly higher GY than TGX1987-10F (1.26Mgha^{-1}). Application of SSP at 40kgPha^{-1} produced tallest plants (131.8cm), highest number of leaves/plant (19.0), number of pods/plant (19.4), and GY (2.28Mg/ha) across the two varieties. Highest K-uptake (6.1mgplant^{-1}) and P-uptake (2.6mgplant^{-1}) were obtained in plants treated with TC+SSP and SSP, respectively. The combination of TC and SSP at 40kgPha^{-1} produced highest number of flowers/plant (35.6), pods/plant (38.7) and GY (3.9Mgha^{-1}). A combination of *Tithonia* compost and SSP applied at 40kgPha^{-1} will increase grain yield of soybean in South-West Nigeria.

Key words: *Phosphorus fertilizer, Tithonia compost, SSP, soybean varieties, Nigeria.*

INTRODUCTION

Soybean yields in Nigeria have been found to be low (Makinde*et al.*, 2001, Adeyemo*et al.*, 2002). This low yield was attributed to many factors which include

declining soil fertility, the use of blanket rate of Phosphorus fertilizer application, low population density and the use of low yielding soybean varieties (IITA, 2000).
Phosphorus (P) is a soybean plant growth-limiting nutrient despite being abundant in soils in both inorganic and organic forms. Phosphorus deficiency can limit nodulation by legumes. However, many soils are phosphorus deficient because the free phosphorus concentration (the form available to plants) even in fertile soils is generally not sufficient (Gyaneshwar et al., 2002; Darryl *et al.*, 2004) Therefore application of phosphorus fertilizer at optimum level is essential. The use of chemical fertilizer is limited mainly by its high cost, long adverse effect when used on soil and environment. Organic inputs generally do not provide sufficient P for optimum crop growth due to their low P concentration (Aulakh*et al*., 2003). However, addition of organic materials as soil amendments has been identified as an alternative approach to application of chemical fertilizers for improved soil fertility and crop productivity in the tropics where most soils are relatively low in fertility. An organic-based fertilizer technology which allows integration of minimum dosage of chemical fertilizer may alleviate the drudgery involved in manure preparation and equally encourage more rapid release of nutrients.
The study was therefore carried out to estimate the optimum P requirement for Soybean production and investigate the response of soybean to different sources of P-fertilizer.

MATERIALS AND METHODS

Two experiments were carried out in the Screen house of the Department of Agronomy, University of Ibadan, Ibadan, Nigeria ($7^0$20'N and $3^0$50'E).

Soil collection

Soil used for the experiment were collected at the depth of 0-15cm from the Teaching and Research Farm at Parry Road, University of Ibadan, Nigeria. The soil used is classified as alfisols according to USDA soil taxonomy classification. Soil collected were air-dried and sieved (2mm and 0.5mm), some portion of the sampled soil was processed in the laboratory to determine the chemical and particle size distribution using the methods described by Udo and Ogunwale (1981).
Experiment 1 - Determination of optimum P application rate for growth and yield of soybean in Ibadan: Treatments in this experiment were: two improved soybean varieties (TGX 1987-10F and TGX 1987-62F) obtained from International Institute of Tropical Agriculture (IITA), Ibadan and single super phosphate (SSP) fertilizer applied at five different rates: 0kgP/ha, 20kgP/ha, 40kgP/ha, 60kgP/ha and 80kgP/ha. The experiment was a 2 x 5 factorial with the two soybean varieties and five application rates laid out in a Completely Randomized Design (CRD) and replicated five times. The experiment was carried out in pots. 10kg soil collected from Teaching and Research Farm, University of Ibadan was weighed to fill each planting pots. The soil was watered to 60% field capacity before planting; three (3) seeds were sown per pot and thinned to one (1).

Experiment 2 - Examining the response of soybean (TGX 1987-62F) to different fertilizer sources at optimum P-rate: The experiment was laid out in a Completely Randomized Design (CRD) with four replicates. The treatments used (at optimum rate of 40kgPha^{-1} obtained from experiment 1) were: SSP, *Tithonia*compost, Poultry manure, *Tithonia* compost plus Poultry manure, SSP plus *Tithonia*compost, SSP plus Poultry manure and Control (no fertilizer). Each treatment was applied to seven (7) pots to give a total of 49 experimental units per replicate and 196 pots in all. Each pots were filled with 10kg sieved soil and watered to 60% field capacity followed by the application of corresponding treatments which was allowed to mineralized for two weeks before the seeds were sowed at three (3) per pot and later thinned to one (1) plant per pot at two weeks after planting.

Data collection

Data were taken on plant height (cm), yield components which include: Number of pods/plant, pod length/plant (cm), pod weight/plant (g), number of seeds/pod, weight of 100 seeds (g) and on grain yield in both experiments.

Data Analysis

Data collected were subjected to statistical analysis using GENSTAT and the treatments means were separated using Least Significant Difference (LSD) at 5% significance of probability.

RESULTS AND DISCUSSION

Influence of Phosphorus (P) rates on morphological and yield parameters of two soybean varieties grown in Ibadan in shown in Table 1. TGX 1987-62F had taller plants (114.6cm), greater number of leaves per plant (18.6cm), more pods per plant (14.08) and grain yield (1.96Mg/ha) than TGX 1987-10F at $p<0.05$. Among P-rates, highest plant height was obtained at 40kgPha^{-1}(131.8cm) significantly higher than values obtained at other rates ($p<0.05$). A similar trend was also observed for number of leaves per plant and number of pods per plant. Highest grain yield was obtained at 40kgPha^{-1}(2.28Mgha-1), significantly higher ($p<0.05$) than grain yield obtained for all other P-rates. Significant variety by P-rates interaction with respect to plant height, leaves per plant and pods per plant indicating that the varieties differed in their response pattern to P. 40kgPha^{-1} was revealed in Experiment 1 to be the optimum rate for soybean production.This results contrast with previous reports by Aulakh et al., 2003: the authors reported that increase in grain yield due to direct application of P to soybean was consistent with increasing rates up to 80kgP_2O_5ha^{-1}. However, Kamara et al., 2008recommended 40kgPha^{-1}for soybean production. TGX1987-62F performed better than TG 1987-10F with regards to all parameters measured and treatments applied. This could be attributed to genetic variability between the two varieties which necessitated its use for Experiment 2.

Table 2 shows the effects of various sources of P at40kgha^{-1} on grain yield and yield parameters of soybean. TC+SSP produced highest number flowers per plant (35.6) significantly higher ($p<0.05$) than number of flowers per plants obtained

from control (16.1), TC+PM (26.3) and PM+SSP (27.5). Highest number of pods per plant (38.7) and highest value for 100 seed weight (10.6g) were also observed in plots that received 40kgPha^{-1} from a combination of TC+SSP. Highest grain yield and dry matter yield were also produced by TC+SSP combination (3.9Mgha-1; 12.5g/pot) though comparable to values obtained at other treatments except the control (1.30Mgha-1; 9.2g/pot)*Tithonia* compost has been reported to produce a nutrient–rich biomass which improves the yield of annual crops. Adediran*et al*., 2003 had earlier reported results that indicate that addition of organic materials as soil amendments as an alternative approach to application of chemical fertilizers for improved soil fertility and crop productivity in the tropics where most soils are relatively low in fertility. In developing countries such as Nigeria, the use of chemical fertilizer is limited by its high cost and long term degradation of the soil and environment. Organic fertilizer although cheaper, may not provide sufficient nutrient in quantityrequired for optimum yield of crops. A combination of both organic and inorganic fertilizers ensures that the physical, chemical and biological requirements of the soil are supplied for the optimum growth and yield of soybean. The results obtained in this study is attributed probably to other nutrient content of*Tithonia*compostand high release of P_2O_5 attribute of SSP (Olabode et al., 2004). Table 3 shows the various sources of P-fertilizer on soybean nutrient uptake at vegetative stage. N-uptake was similar for all fertilizer sources ($p<0.05$). Highest P-uptake was observed in plots treated with SSP (2.6mgplant^{-1}) though not significantly different from P-uptake in plots treated with TC+SSP and PM+SSP. K-uptake was highest in plots treated with TC+SSP(6.10mgplant$^{-1)}$ significantly higher than K-uptake obtained at other P-fertilizer treatments ($p<0.05$).

Table 1. Influence of Phosphorus (P) rates on morphological and yield parameters of two soybean varieties grown in Ibadan, Nigeria

	Morphological and yield parameter				
	Max. Plant height (cm)	Max. No Leaves per plant	Pods per plant	100 seed Weight(g)	Grain yield (Mg/ha)
Variety (V)					
TGX 1987-10F	105.0	13.6	10.24	7.5	1.26
TGX 1987-62F	114.6	18.6	14.08	8.7	1.96
LSD (0.05)	6.01	1.79	1.38	1.7	0.31
P-rates KgPha^{-1}(P)					
0	98.3	15.4	8.8	6.4	0.72
20	99.3	16.9	9.9	7.9	1.51
40	131.8	19.0	19.4	10.7	2.28
60	109.8	12.7	11.1	7.8	1.68
80	104.9	16.8	11.6	7.7	1.55
LSD (0.05)	9.6	2.78	2.35	ns	0.49
V x P	*	*	*	ns	ns

V x P-rate: Varieties by P-rates interactions*: significant at ($p \leq 0.05$), ns: not significant. LSD: least significant difference. Max: maximum.

Table 2. Effects of various sources of P at optimum rate (40kgPha^{-1}) on grain yield and yield components of Soybean grown in Ibadan, Nigeria

P-Sources (40kgha^{-1})	Flowers per plant	Pods per plant	100 seed weight (g)	Dry matter yield (g/plant)	Grain yield (Mg/ha)
Control	16.1	23.7	6.6	9.2	1.30
Single superphosphate	31.1	30.7	10.3	10.4	3.20
*Tithonia*compost	30.0	27.7	8.8	10.7	3.06
Poultry manure	30.5	28.0	7.8	12.2	2.79
Tithonia compost + Poultry manure	26.3	36.0	7.9	12.1	2.37
*Tithonia*compost + SingleSuperphosphate	35.6	38.7	10.6	12.5	3.90
Poultry manure +Single superphosphate	27.5	35.0	8.3	11.7	2.48
LSD (0.05)	6.45	7.6	1.14	1.0	1.02

LSD: least significant difference.

Table 3. Influence of various sources of optimum P on nutrient uptake of Soybean

	Nutrient Uptake (mg/plant) at vegetative stage		
P-sources at 40kgPha^{-1}	N	P	K
Control	2.30	1.10	2.90
Single superphosphate	2.50	2.60	4.40
Tithonia compost	2.50	1.90	3.50
Poultry manure	2.70	1.80	4.20
Tithonia compost + Poultry manure	2.50	1.60	4.00
Tithonia compost + SingleSuperphosphate	2.60	2.50	6.10
Poultry manure +Single superphosphate	2.70	2.20	4.50
LSD (0.05)	ns	0.62	1.30

ns: not significant; LSD: least significant difference

CONCLUSION

Results of the present investigation with soybean influenced by different rates and sources of P- fertilizer in south-western Nigeria have shown that monoculture of soybean require 40kgPha^{-1}, higher P-fertilizer rates produced no significant increase in grain yield and related parameters of soybean. This study provides evidence that a combination of organic and inorganic fertilizers produced significantly higher dry matter and grain yield in soybean.*Tithonia*compost combined with SSP applied at 40kgPha^{-1} will increase the yield of soybean (*Glycine max*) in South west Nigeria.

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