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Response of Soybean (*Glycine max* (L.) Merr.) to Application of Poultry manure and Mineral fertilizers in the Agro-ecological Zone III of Cameroon

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Abstract – Declining soil fertility and inappropriate fertilizer application greatly reduce crop yields. A study was carried out at the experimental field of the Institute of Agricultural Research for Development (IRAD) Bambui, located in the agro-ecological zone III of Cameroon to assess the effects of poultry manure and inorganic fertilizers on the growth, nodulation and grain yield of soybean. The experiment was arranged in a randomized complete block design (RCBD) with three replications and four treatments (T1: control: no input, T2: 2.5 tons ha^{-1} poultry manure, T3: 200kg ha^{-1} NPK and T4:100kg ha^{-1} Urea). Experimental plots measuring 4m x 3m were laid out. Planting was done at a spacing of 50cm x 10cm (at the rate of 2 plants per stand) to maintain a plant population of 400,000 plants per hectare. All cultural practices were carried out from planting to harvesting. Data taken on plants included plant height (cm), number of leaves per plant, canopy spread per plant (cm), number of nodules per plant, number of efficient nodules per plant, nodule fresh and dry weights (g) per plant, number of pods per plant, pod fresh and dry weights (g) per plant, number of filled pods per plant and grain yield (tons ha^{-1}). Analysis of Variance was carried out to find the differences between the various parameters and the LSD Fisher's Test was used to compare the different treatments. The results of the experiment showed that the application of Poultry manure showed a more remarkable and significant ($P<0.05$) increase in the growth, nodulation and yield of soybean. This was followed by the NPK fertilizer treatment which did not differ significantly ($P>0.05$) from the control and urea treatments in terms of yield. This study confirms the role of poultry manure in improving soybean yield. From the results obtained, poultry manure may be recommended for increasing soybean yield in the study area. However, the application of NPK and Urea fertilizers can also increase soybean yield.

Keywords – Soybean, Growth, Nodulation, Yield, Poultry Manure, Mineral Fertilizer.

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I. Introduction

Soybean (*Glycine max* (L.) Merr.) is a grain legume widely consumed in the world as a bean and in many other forms of derived products (milk, meat…) due to its high protein content. The global annual production of soybean is 334.9 million tonnes. The USA, Brazil and Argentina contribute to about 81% of the global production. The leading African producers are South Africa, Uganda and Nigeria [1], cited in Foncha *et al* [2]. Despite the fact that soybean production in Cameroon has increased from 12,544 tonnes (in 2010) to 27,022 tonnes (in 2018), the country insignificantly contributes to 0.0% of the global production [3]. This low production does not meet the national soybean demand which has been increasing with constant demand from the poultry, animal feed and the food processing industries. This has therefore resulted to the importation of huge quantities of soybean to meet up with the national demand. The low soybean production in Cameroon is due to the fact that most of the producers are peasant subsistent farmers who have little or no knowledge on an appropriate soil fertilization technique.

Nitrogen is one of the major nutrients needed for soybean growth and development. The symbiotic nitrogen fixing bacteria (Rhizobia), found in the root nodules of soybean can convert the in accessible atmospheric nitrogen to soil nitrates that are assimilated by the host plant [2], showing an antagonistic effect against soil borne pathogens and hence increasing the soil fertility [4], cited in Mamia *et al* [5].

The application of poultry manure singly or in combination with other mineral fertilizers has shown to improve soybean growth and yield [1], cited in Mamia *et al* [5]. Very little work has been carried out to investigate the performance of poultry manure on soybean growth and yield. The present study was therefore carried out to assess the effect of two mineral fertilizers (NPK and Urea) and poultry manure on the growth, nodulation and yield of soybean under rain field conditions.

II. Materials and Methods

2.1. Study site

The study was carried out at the experimental field of the Institute of Agricultural Research for Development (IRAD) Bambui, at the Nfonta Sub-Station of the agro-ecological Zone III of Cameroon. Nfonta is a low land located at the elevation of 1250m above sea level with savanna vegetation. This area is characterized by a moderate rainfall of 2230mm/annum uniformly distributed from mid-March to mid-November with the highest peak of 380mm occurring in the month of July and August. The temperatures are slightly cold with an average minimum and maximum of 18 and 28°C respectively. It has an average humidity of 75% and 52% in the rainy and dry season respectively. This area has a well-drained soil which is good for crop production [2].

2.2. Land preparation

A tractor was used to plough the field and harrowing was manually made using hoe to pulverize the soil. Plots were then demarcated in the experimental field. Each plot had a dimension of 4m by 3m with a distance of 0.75m between plots and 1m separating one block (replication) from the other. The experimental field measured 15m by 14.25m (213.75m^2).

2.3. Experimental design

The experiment was laid out in a randomized complete block design (RCBD) and replicated three times with treatments shown in Table 1 below:

Table 1: Treatments applied to the experiment

T1	Control (no input)
T2	Poultry manure (2.5 tonha^{-1})
T3	NPK fertilizer (200 Kgha^{-1})
T4	Urea fertilizer (100 Kgha^{-1})

2.4. Panting and cultural practices

Soybean seeds (TGX1485-1D), obtained from the Institute of Agricultural Research for Development Bambui, were sown in April 2018 in rows of 50cm apart and plant-to-plant distance of 10cm. Three seeds were sown per stand and thinning was later done two weeks after germination, leaving two plants per stand with the aim of achieving a plant population of 400,000 plants ha^{-1}. Hand weeding was constantly made to maintain the field weed free. Insects and pests were controlled by spraying the plants with EMACOT insecticide whenever there was any visible sign of attack. The fertilizer and manure treatments were made immediately after thinning at the rates shown in Table 1.The poultry manure applied had previously been collected and allowed to decay. All other cultural practices were strictly followed from planting to harvesting. The crop was harvested in September 2018 when 80% of the pods colour turned brown.

2.5. Data collection

Data was collected at different stages of crop's life cycle (3, 6, 9, and 11 weeks after planting, peak flowering) on the plant height, number of leaves per plant, canopy spread, nodulation and yield parameters as shown in Table 2 below:

Table 2: Description of the data collected during the study

Plant height (m)	The heights of 10 randomly tagged middle row plants were measured from ground level to the tip of the main stem for each treatment using a measuring tape and the mean height per plant determined for each treatment
Number of leaves per plant	Leaves were counted from the 10 tagged plants and the mean number per plant determined for each treatment
Canopy spread	The broadness of the canopy of the 10 tagged plants was measured using a measuring tape and the mean canopy spread per plant computed for each treatment
Nodule number and nodule efficiency	At peak flowering, nodules were collected from 10 other randomly selected plants, washed, counted and the mean number per plant determined for each treatment. The nodulation efficiency was determined by cutting the fresh nodule with a razor blade and checking the pink colouration which is an indication of the presence of leghaemoglobin that justifies the nodule ability to fix nitrogen or efficiency [2]
Nodule fresh and dry weights	The fresh weights of the nodules harvested were measured using an electronic scale balance and the mean number per plant for each treatment recorded. The nodules were sun dried for 5 days and similar procedure followed to obtain the nodule dry weights
Number of pods per plant	Pods were counted from the 10 randomly tagged plants and the mean number of pods per plant for each treatment determined
Number of filled pods per plant	Number of filled pods were counted from the 10 randomly tagged plants and the mean number of filled pods per plant for each treatment determined
Number of grains per pod	This was achieved by harvesting and counting the pods from 10 randomly selected plants. The grains were shelled and counted. The average number of grains per pod for each treatment was calculated
Grain yield	It was obtained by shelling and drying the grains harvested from $1m^2$ plot for each treatment and the yield calculated using the following equation: $\text{Grain yield} = \left(\frac{\text{Dry weight of soybean grains from 1 square metre}}{1000} \times 10{,}000\right) \text{tonsha}^{-1}$

2.6. Data analysis

The data obtained were analysed with the aid of the STATGRAPHICS Plus version 5.0 Software. The analysis of variance (ANOVA) was run to find the differences between the various treatments and the LSD Fisher's test at 95% confidence level was used to compare the different treatments.

III. Results and Discussion

3.1. Effects of poultry manure and mineral fertilizers on soybean growth

Plant height: The data recorded in table 3 show that plant height increased across all the treatments at all the growth stages. At 3WAP, the control treatment (T_1) showed

significant difference (P< 0.05) in the plant height compared to the other treatments. There was no significant difference (P>0.05) in the plant height in the poultry (T_2), NPK (T3) and urea (T4) treatments. At 6WAP, the control treatment (T_1) and the poultry treatment (T_2) showed significant difference in plant height with respect to the other treatments while there was no significant difference (P>0.05) in the plant height in NPK and Urea treatments. At 9WAP, the urea treatment showed a significant difference in the plant height from the rest of the treatments which did not show any significant difference. At 11WAP, the Urea and NPK treatments did not differ significantly in the plant height.

Table 3: Effects of poultry manure and inorganic fertilizers on plant height

Treatment code	**Treatment**	**3WAP**	**6WAP**	**9WAP**	**11WAP**
T_1	Control	10.33^{c}	16.60^{d}	33.97^{c}	59.80^{b}
T_2	Poultry	12.53^{ab}	22.0^{a}	32.80^{c}	63.20^{a}
T_3	NPK	13.20^{a}	19.80^{c}	32.60^{c}	55.20^{c}
T_4	Urea	12.93^{a}	20.0^{c}	35.40^{a}	63.73^{a}

In a column, means with the same letters are not significantly different (Fisher's test, 5%)

Number of leaves per plant: The results shown in Table 4 reveal that the number of leaves per plant increased across the plant growth stages for all treatments. There was no significant difference (P>0.05) in the number of leaves per plants at 3WAP for all the treatments. At 6WAP, the number of leaves per plant in the urea treatment differed significantly (P<0.05) from those in the other treatments. At 9WAP, the number of leaves per plant from the T3 and T4 treatments did not differ significantly (P>0.05). The T2 treatment had the highest number of leaves per plant and differed significantly from the rest. At 11WAP, there was no significant difference in the mean number of leaves per plant from the poultry manure and NPK treatments. The urea treatment recorded the lowest number of leaves and differed significantly from the rest.

Table 4: Effects of poultry manure and inorganic fertilizers on number of leaves per plant

Treatment code	Treatment	3WAP	6WAP	9WAP	11WAP
T_1	Control	8.27^{a}	12.87^{bc}	24.20^{d}	44.67^{b}
T_2	Poultry	9.93^{a}	14.93^{ab}	34.13^{a}	46.47^{a}
T_3	NPK	8.83^{a}	13.67^{b}	25.83^{b}	45.60^{a}
T_4	Urea	9.27^{a}	15.67^{a}	26.07^{b}	39.80^{c}

In a column, means with the same letters are not significantly different (Fisher's test, 5%)

Canopy spread: The results presented in Table 5 show that the canopy spread increased across the plant growth stages for all treatments. At 3 WAP, the control plot (T_1) and Urea plot (T_4) showed no significant difference (P>0.05) in the canopy spread. A similar situation was observed in the poultry and NPK plot. At 6WAP and 9WAP, the canopy spread in the Urea treatment (T_4) differed significantly (P>0.05) from the rest of the treatments. At 11WAP, the canopy spread in the control treatment (T_1) and NPK (T_3) differ. There was no significant difference in the canopy spread from the poultry (T_2) and Urea (T_4) treatments.

Table 5: Effects of poultry manure and inorganic fertilizers on canopy spread

Treatment code	Treatment	3WAP	6WAP	9WAP	11WAP
T_1	Control	9.20^{d}	18.57^{c}	31.07^{b}	39.80^{c}
T_2	Poultry	9.87^{a}	20.27^{c}	31.33^{b}	40.53^{a}
T_3	NPK	9.87^{a}	19.73^{c}	30.53^{b}	39.80^{c}
T_4	Urea	9.0^{d}	22.0^{a}	32.80^{a}	42.33^{a}

In a column, means with the same letters are not significantly different (Fisher's test, 5%)

3.2. Effects of poultry manure and inorganic fertilizers on nodulation

The information in Table 6 reveal that the control plot had the lowest number of nodules per plant, number of effective nodules, nodule fresh weight and nodule dry weight. The poultry manure treatment (T_2) recorded the highest in all the nodulation parameters. There were significant differences ($P<0.05$) in the mean number of nodules per plant for all the treatments. The control treatment recorded the lowest number of efficient nodules per plant and differed significantly from those of the other treatments. The poultry manure treatment had the highest number of efficient nodules per plant but did not differ significantly ($P>0.05$) from those in the NPK and urea treatments. The control treatment recorded the lowest nodule fresh and dry weights and differed significantly from the others. The poultry manure treatment had the highest nodule fresh and dry weights.

Table 6: Effects of poultry manure and inorganic fertilizers on nodulation

Treatment code	Treatment	Number of nodules	Number of efficient nodules	Nodule fresh weight/g	Nodule dry weight/g
T_1	Control	14.27^{d}	7.60^{c}	1.70^{c}	0.33^{e}
T_2	Poultry	20.87^{a}	11.40^{ab}	2.47^{ab}	0.80^{ab}
T_3	NPK	19.20^{b}	9.27^{b}	2.07^{b}	0.63^{bc}
T_4	Urea	15.73^{c}	7.64^{c}	1.97^{b}	0.47^{d}

In a column, means with the same letters are not significantly different (Fisher's test, 5%)

3.3. Effect of poultry manure and inorganic fertilizers on soybean yield and yield components

Poultry manure treatment showed the highest scores in yield parameters (Table 7). Apart from grain dry weight, there was a significant difference ($P<0.05$) between the poultry manure treatment and the rest of the treatments for all the other yield data. Similarly, apart from the number of filled pods per plant, the control treatment recorded the lowest score for all yield data. Highest yield was recorded in the poultry manure treatment, while the lowest was recorded in the control treatment.

Table 7: Effects of poultry manure and inorganic fertilizers on soybean yield and yield components

Treatment code	Treatment	No. of pods/plant	No. of grains /pod	No. of filled pods	Pod fresh weight/ g	Grain fresh weight/ g	Grain dry weight/g	Plant biomass/g	Yield in tons/ha
T_1	Control	54.27^{b}	2.03^{cd}	59.0^{b}	37.67^{c}	21.33^{b}	11.67^{b}	71.0^{e}	3.07^{d}
T_2	Poultry	98.87^{a}	2.27^{a}	90.67^{a}	75.0^{a}	55.33^{a}	26.0^{a}	102.0^{b}	6.93^{b}
T_3	NPK	71.53^{b}	2.13^{b}	60.33^{b}	51.0^{b}	34.33^{b}	17.33^{ab}	86.0^{d}	4.63^{cd}
T_4	Urea	61.93^{b}	2.13^{b}	52.33^{c}	42.0^{b}	27.67^{b}	14.33^{b}	76.67^{d}	3.83^{d}

In a column, means with the same letters are not significantly different (Fisher's test, 5%)

IV. Discussion

4.1. Effects of poultry manure and mineral fertilizers on soybean growth

Parameters like plant height, number of leaves per plant and canopy spread increased with poultry manure and mineral fertilizer application. A previous report [7] has shown that poultry manure contains important plant nutrients like nitrogen and phosphorus (just like the mineral fertilizers) that enhance cell division and thereby increase growth and development. The plant growth parameters also showed increased trend with the increase in growth stages. Generally, the growth parameters from the other treatments showed increased recordings over the control treatment. These findings coincide with those revealed in other similar studies, [5], [8].

4.2. Effects of poultry manure and mineral fertilizers on nodulation

The poultry manure and NPK fertilizer applications the highest number of efficient nodules (indicated by the presence of the pink colouration after cutting across the nodule) that can fix nitrogen and render it assessable to the host plant [2]. These results agree with those from an earlier study [7] that recorded higher nodulation with poultry manure and phosphorus application.

4.3. Effects of poultry manure and mineral fertilizers on soybean yield

The results of this finding reveal that the poultry manure, NPK and urea treatments recorded higher yields as compared to the control treatment. This might be as a result of the higher number of pods per plant, grains per pod, filled pods per plant and dry grain weight. This might further be attributed to the fact that there was adequate plant nutrient supply at the appropriate moment from the poultry manure and mineral fertilizers. These findings are accordance to those revealed from similar previous studies in soybean [5], [9] and maize [10].

V. Conclusion

The results from this study reveal that poultry manure significantly improved soybean growth, nodulation and yield. The application of NPK and urea fertilizers also improved the crop yield. Poultry manure should be highly recommended for soybean production in the study area.

References

[1] **FAOSTAT, (2017)**. Statistics database and datasets of the Food and Agriculture Organization of the United Nations. http://www.faostat.fao.org/. Accessed 27 July 2017.

[2] **Foncha, F., Laurette, N.N., Kamguia, K., Mounkam, T.F., Fankem, H., Adamou, S., Ngakou, A. and Nwaga, D. 2019**. Solubilization of Rock Phosphates by Indigenous Rhizobia Nodulating Soybean (*Glycine max* (L.) Merr.) Isolated from Two Cameroonian Soils. *International Review of Humanities and Scientific Research*, 4(1): 65-86.

[3] **FAOSTAT 2018.** Statistical database of the Food and Agriculture Organization of the United Nations. http://www.faostat.org/.

[4] **Mahabad, R. 1986.** High yielding varieties of crops. All Indian Co-coordinated Barley Improvement Project, IARI Regional Station Kamal (Haryana), p. 641.

[5] **Mamia, A., Amin, A.K.M.R, Roy, T.S. and Faruk, G.M. 2018.** Influence of Inorganic and Organic fertilizers on Growth and Yield of Soybean. *Bangladesh Agron. J.* 2(1):77-81.

[6] **Javed, S. and Panwar, A. 2013.** Effect of Biofertilizer, Vermicompost and Chemical fertilizer on Different Biochemical Parameters of *Glycine max* and *Vigna mungo*. *Recent Sci. Technol*. 5: 40-44.

[7] **Chiezey, U.F. and Odunze, A.C.2009.** Soybean Response to Application of Poultry manure and Phosphorus fertilizer in the Sub-humid Savana of Nigeria. *Journal of Ecology and Nutritional Environment.* 1(2):25-31.

[8] **Pati, H.M. and Udmale, K.B. 2016.** Response of Different Organic inputs on Growth and Yield of Soybean on Inceptisol. *Scholarly J. Agril. Sci*. 6(5):139-144.

[9] **Falodun, E.J., Ehigiator, J.O. and Ogedegbe. 2015.** Growth and yield Response of Soybean (*Glycine max* Merr.) to Organic and Inorganic Fertilizers in Edo Rainforest of Nigeria. *American J. Plant Sci*. 6: 3293-3297.

[10] **Foncha, F., Wirnkar, L.V., Bame, I.B., Nsuh, K.C., Mbong, B. and Mbong, G.A. 2019.** Growth and Yield response of Maize (*Zea mays*.) to Different Rates of NPK fertilizer and Poultry Manure in the Western Highlands of Cameroon. *International Journal of Advances in Scientific Research and Engineering*, 5(4):233-239.