Original Research Article

Comparative Effects of Different Levels of Bio-fertilizer on the Growth and Yield Attributes of Greengram (*Vigna radiata* (L) Wilczek) in the Screenhouse.

Abstract

Aim: to investigate growth and yield response of greengram to different levels of Kolgrace bio-fertilizer with a view to determine the most favorable application rate for greengram production.
Study Design: completely randomized design (CRD) with treatments replicated five (5) times.
Place and Duration of Study: Screenhouse of the Department of Agronomy, University of Ibadan, Nigeria, between July to November 2016.
Methodology: six levels of kolgrace bio-fertilizer were used (0.00, 0.50, 1.00, 2.00, 4.00 and 8.00 t ha^{-1}). Top soil (0 -15cm) was collected from the Teaching and Research Farm of the Department of Agronomy, and leached of nutrients by soaking and washing in water for 24 hours. 2 kg of air-dry soil was mixed with the appropriate fertilizer rate and filled in each pot **(Application rate is in t/ha as mentioned above but how the fertilizer rate was mixed with soil in kg?).** 3 seeds were sown per pot and thinned to 1 seed at 2 weeks after sowing (WAS). Chemical analysis of air-dry soil sample and Kolgrace fertilizer were done at the soil chemistry laboratory of the Department of Agronomy, University of Ibadan, Nigeria, to ascertain their elemental composition. Soil particle size distribution (Bouyoucos hydrometer method), Soil pH (electrometric method), exchangeable K and Na (Flame photometry), exchangeable Mg and Ca (Atomic absorption spectrophotometer (AAS), exchangeable acidity (KCl extraction method), organic carbon and organic matter (Walkey and Black procedure), available P (Bray P-1), Nitrogen (Kjedahl) and micronutrients (Mn, Fe, Cu and Zn) (AAS method) were determined.
Results: Application rates were significant ($p<0.05$) for all the traits measured. 0.5 t ha^{-1} was significantly higher in plant height (39.5), number of pods (7.0) and dry pod weight (4.98). Application rate of 1 t ha^{-1} was higher in number of leaves (18.0) although was comparable to application rate of 0.5 t ha^{-1}.
Conclusion: Application rate of 0.5 t ha^{-1} was best for three of the five traits measured and is hereby recommended.

Keywords: Greengram, Organic fertilizer, Manure rate, Mungbean, Growth response, Bio-fertilizer

INTRODUCTION

Greengram (*Vigna radiata* (L.) R. Wilczek) is a leguminous pulse belonging to the pea family, Fabaceae [1]. It is a small, round, olive green pea with sweet flavour and good texture. Originally native to Asia, its relevance and domestication is gradually spreading to other parts of the world, owing to its enormous marketing and nutritional potentials that are yet to be fully exploited in most parts of the world [2] in comparison to other grain legumes. Greengram ranks amongst the top most important legume food crops in Asia [2], and in southern parts of Europe and USA [3,4]. Primarily cultivated for its seeds and sprouts, which are consumed by man and livestock, other economic importance of the crop abound which cannot be overemphasized. Seeds of greengram have proven to be a very important source of easily digestible protein (up to 30% of dry matter) [3, 5] and carbohydrate (about 45% DM), with negligible amount of lipid (less than 2% of DM) and relatively low amount of fibre (up to 6.5% of DM). The amino acid profile of greengram is comparable to what is found in soybean [5]. Nutritionally, greengram ranks first among pulses [6, 7] and can serve as an excellent substitute to fishmeal (up to 25%) [8] and soybean meal [9] in fish feeds; and can be introduced to layers feed (up to 30% of control diet) and broilers mash (up to 40%) either raw or processed into pellets without negatively affecting egg production, growth or feed efficiency rates [10]. The seeds are easy to cook and do not cause flatulence [11], giving it an edge over cowpea. Its ability to exist in a symbiotic relationship with bacteria in the root nodules, thereby fixing nitrogen up to 50 kg ha^{-1} [12] is an added advantage especially in areas of low soil fertility. Greengram can play vital roles in environmental conservation (as a cover crop and nitrogen fixer), food and income security, and also in sustainable agriculture [13]. Demand for cheap sources of protein is on the rise in Nigeria and Africa, and the excess of demand over supply of animal protein (which has culminated into high cost of meat products), over-dependence on soybean and cowpea products for food and feed and their high industrial value has grossly reduced their availability to the poor. There is therefore the urgent need to look out for alternative and affordable sources plant protein that can thrive in less fertile soils, since soil infertility is a major limiting factor of crop production in Nigeria, as is the case with most tropical and subtropical regions of the world [14]. Fortunately, organic fertilizer is proving a worthy alternative to chemical fertilizers [15] as in addition to releasing nutrients in adequate amounts; it also improves soil structure [16] and microbial biomass [17]. [18] opined that the use of chemical fertilizers is not sustainable owing to its accompanying detrimental effects such as leaching, persistent increase in soil acidity, depleting soil organic matter and degraded soil physical conditions, among others. There is therefore the need to explore organic fertilizer alternatives that are environmental friendly and sustainable, in addition to improving productivity. Hence, developing organic fertilizer recommendation will not only help to improve crop yields but can also help farmers to estimate the precise quantity that would be optimum for a specific production task, thereby eliminating the ugly effects of under and over-application. Significant improvement in growth and yield of crops with addition of organic fertilizers has been reported [19], and grain yield of 1-1.2 t ha^{-1} is possible [4]. This research was therefore carried out to investigate the rate of Kolgrace organic fertilizer for optimum greengram production.

MATERIALS AND METHODS

Experimental Site

A pot experiment was carried out at the screenhouse of the Department of Agronomy, Parry Road, University of Ibadan, Nigeria. Parry Road has elevation of 189 m above sea level and situated at Latitude $07^{\circ} 27^{1}$ N and Longitude $03^{\circ} 53^{1}$ E.

Treatments and Experimental Design

Six (6) rates, 0.00, 0.50, 1.00, 2.00, 4.00 and 8.00 t ha^{-1} of Kolgrace (a commercial product) organic fertilizer obtained from the Department of Agronomy, University of Ibadan, was used for the study. The design of the experiment was completely randomized design (CRD), with five (5) replications of treatments. Top-soil collected from the Department of Agronomy Teaching and Research Farm, University of Ibadan, was leached by soaking in water (for 24 hours), washing and rinsing severally before air-drying. Using a 2 mm sieve, gravel and other inert particles were excluded from the air-dry soil before taken to the laboratory for analysis. 2 kg of air-dry soil was mixed with the appropriate fertilizer rate and filled in each pot; thereafter pots were watered and left for 24 hours before sowing. Prior to sowing, seeds were hydro-primed by soaking in water overnight for 12 hours. 3 seeds were sown per pot and thinned to 1 seed at 2 weeks after sowing (WAS). The seedlings were watered once in two days as the crop does not thrive in water logged conditions. Hand weeding was done as appropriate to allow for reduced competition by the weeds.

Soil and Kolgrace Analysis

Chemical analysis of air-dry soil sample and Kolgrace fertilizer were done at the soil chemistry laboratory of the Department of Agronomy, University of Ibadan, Nigeria. The following chemical properties: soil particle size distribution [20], Soil pH [21], exchangeable K and Na [22], exchangeable Mg and Ca [23], exchangeable acidity [24], organic carbon **(data on this parameter was not presented in table)** and organic matter [25], available P [26], Nitrogen [27] and micronutrients (Mn, Fe, Cu and Zn) [23] were determined.

Data Collection

Data were collected on plant height (from plant base to plant tip), number of leaves per plant (counted as number of fully expanded leaves), and stem diameter per plant (taken at 2 cm from the base with a venier caliper) at intervals, while number of pods per plant and dry pod weight per plant were collected at harvest. **(As objective of the study work is to investigate the growth and yield attributing characters of greengram, while the observation relate to this characters were very few).**

Statistical Analysis

All data were subjected to analysis of variance (ANOVA) using Genstat statistical package (4^{th} Edition) and means were separated using Duncan's multiple range test (DMRT) at $p<0.05$.

RESULTS AND DISCUSSIONS

Physicochemical properties of soil

Analysis of particle size distribution of the soil showed that the soil was composed of sand (766 g kg^{-1}), silt (140 g kg^{-1}) and clay (94 g kg^{-1}) indicating that the soil is sandy loam, and suitable for the experiment. The result of soil chemical analysis revealed that the soil reaction was neutral with pH of 7.0, which suggests that soil nutrients were available at optimum levels. This is in agreement with [28] who reported that plant nutrients are optimally available and compatible to plants roots within the pH range of 6.5-7.5. Both total nitrogen (N) and potassium (P) were at critical levels in the soil, while the available phosphorus (P) was deficient and below the critical level (Table 1). The critical state of N, P and K elements in the soil suggests that the variation observed with respect to the various parameters measured can be implicated on treatments applied and not on the inherent soil fertility.

(The paper is more remarkable if the parameters of physicochemical properties of soil after application of fertilizer are also mentioned)

Chemical properties of kolgrace organic fertilizer

Table 2 shows the percentage of nutrient elements present in Kolgrace organic fertilizer. Total N, available P, and K were very high, with pH slightly alkaline. The analysis proved beyond doubts that the organic fertilizer can provide an adequate amount of macro and micro nutrients needed for growth and development of the crop.

Plant Height

The effects of different rates of Kolgrace Fertilizer on plant height are shown in Table 3. Data revealed that fertilizer rates significantly influenced plant height of greengram. Application rate of 0.5 t ha^{-1} gave the best performance and was shown to significantly increase (*p<0.05*) plant height by 15 percent when compared to the control. Beneficial effects of organic fertilizers in improving growth parameters of mungbean have been widely documented [29, 30, 31]. Kolgrace application rates greater than 0.5 t ha^{-1} were seen to have smothered growth of the plant as was evident in the reduction in plant height with marginal increase in rates of the fertilizer, which does not align with the submissions of [31] who reported significant increase in plant height with increasing level of cow dung application.

Number of leaves

The different Kolgrace rates showed significant variation for number of leaves. Application rates of 1 t ha^{-1} and 0.5 t ha^{-1} were statistically similar, but gave significantly higher ($p < 0.05$) number of leaves than 0, 2, 4 and 8 t ha^{-1}, which could be attributed to the richness of the fertilizer on one hand, the crop's ability to fix nitrogen on the other hand and the low nutrient requirement of greengram in relation to other crops, which had previously been documented [32, 33, 34, 13].

Stem diameter

Kolgrace application rates showed significant difference ($p<0.05$) for stem diameter. Application rates of 0, 0.5, 1 and 2 t ha^{-1} gave statistically similar results for stem diameter but differed significantly from application rates of 4 and 8 t ha^{-1}, which were the poorest. This suggests a smothering effect of higher application rates on the trait.

Table 1: Physicochemical properties of the soil.

Parameters	Value
Physical Properties	
pH (H_2O – 1:1)	7.0
Particle Size Distribution (g/kg)	
Sand	766.0
Silt	140.0
Clay	94.0
Texture	Sandy Loam
Chemical Properties	
Organic matter (g/kg)	14.0
Total nitrogen (g/kg)	2.3
Available phosphorus (mg/kg)	4.9
Potassium (K)	0.2
Calcium (Ca)	1.3
Magnesium (Mg)	0.6
Sodium (Na)	13.1
Copper (Cu)	0.20
Manganese (Mn)	62.80
Zinc (Zn)	0.51
Iron (Fe)	21.20

Table 2: Chemical properties of kolgrace organic fertilizer

Properties	Value
pH (H_2O – 1.2)	7.5
Total Nitrogen (%)	4.6
Total Phosphorus (%)	1.8
Total Potassium (%)	5.3
Total Calcium (%)	5.2
Total Magnesium (%)	2.2
Total Sodium (%)	0.1
Total Zinc (mg kg^{-1})	15.3
Total Iron (mg kg^{-1})	102.5
Total Copper (mg kg^{-1})	31.0
Total Manganese (mg kg^{-1})	344.5

Table 3: Effect of kolgrace organic fertilizer rates on growth and yield of mungbean

Rates (t ha $^{-1}$)	Plant Height (cm)	Number of Leaves	Stem Diameter (mm)	Number of Pods	Dry Pod Weight **(t ha $^{-1}$) ?**
0	34.3b	12.0b	2.29a	5.0a	0.56c
0.5	39.5a	15.0ab	2.24a	7.0a	4.98a
1	33.6b	18.0a	2.09a	5.8ab	4.50a
2	29.6b	14.0b	2.09a	4.0b	3.53ab
4	21.6c	8.0c	1.47b	2.0c	2.06b
8	12.1d	12.0b	1.68b	1.0c	1.96b

Means with the same letter are statistically similar to each other

(Plant spread, number of branches per plant, pod length and breadth, fresh and dry weight of pod/plant, number of seed per pod, pod yield/plant and pod yield (t/ha) are important characters from growth and yield attributing parameters)

Number of pods per plant

Greengram showed significant ($p<0.05$) variation for number of pods when different rates of Kolgrace fertilizer was applied. Application of 0.5 t ha $^{-1}$ and 1 t ha $^{-1}$ produced comparable number of pods per plant, and were significantly higher than the rest of the treatments. The significantly higher performance of lower levels (0.5 and 1 t ha $^{-1}$) of Kolgrace fertilizer in contrast to higher levels (2, 4 and 8 t ha $^{-1}$) could be implicated on the very high concentration of N, P and K in addition to the good balance of trace elements in the organic fertilizer, thereby requiring low application rates for optimum yield. It could also suggest efficient release and utilization of nutrients by the organic fertilizer, thereby making primary growth elements available in sufficient amounts. Similar results were also reported [15, 30].

Dry pod weight

The effect of Kolgrace application rates on dry pod weight (DPW) of greengram was significant. Application of 0.5, 1 and 2 t ha $^{-1}$ produced comparable yields which were significantly higher ($p<0.05$) than 4, 6 and 8 t ha $^{-1}$, respectively. Application rate of 0.5 t ha $^{-1}$ produced the highest pod weight of 4.98 t ha $^{-1}$. Although, differences in pod weight among application rates of 0.5, 1 and 2 t ha $^{-1}$ were insignificant, a gradual reduction in DPW was observed with marginal increase in kolgrace application rates (Table 3). These findings suggests that application rate of 0.5 t ha^{-1} supplied optimum amounts of all essential elements needed for growth, flowering and seed setting compared to higher rates which probably suffocated the plants due to overdose. It could also be attributed to the lower irrigation and nutrient requirement of the crop in comparison to other crops. This report corroborates the submissions of [32, 33, 34, 13], but contradicts the findings of [31, 19].

SUMMARY AND CONCLUSION

The effect of varying rates of Kolgrace organic fertilizer was significant in all the traits measured. Application rate of 0.5 t ha^{-1} produced consistently higher results across the five traits measured. The significantly higher performance of 0.5 t ha^{-1} of Kolgrace fertilizer in contrast to its higher levels could be implicated on the very high concentration of N, P and K in addition to the good balance of trace elements in the organic fertilizer as revealed by the chemical analysis (Table 2). This study has been able to establish that greengram does not require heavy doses of fertilizer to produce optimally. In addition, Kolgrace Organic fertilizer has by this finding proven to be a good alternative to chemical fertilizer by requiring low application rates for optimum yield.

Conclusively, application rate of 0.5 t ha^{-1} is best for green production in the study area and is hereby recommended.

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