Effect of bat guano on the growth of *Vigna radiata* L.

Shrinidhi Shetty*, K.S. Sreepada, Rama Bhat***

*Department of Biotechnology, Alva's College, Moodbidri, -574227 D.K. Karnataka,India.
Email: srimicrotech@yahoo.com , bhat_pr@rediffmail.com

** Department of Applied Zoology, Mangalore University,Mangalagangothri - 574 199 D.K.
Karnataka, India, Email: sri_kpada@yahoo.co.in

Abstract- Bat guano is known to contain all the macro and micronutrients that plants require in a natural form and hence ably serve as plant fertilizer, soil builder, soil cleanser, fungicide, nematocide and compost activator. In ancient times it was used in agricultural practice as manure but with advent of chemical fertilizers its usage became less popular. Health menace created by chemical fertilizers is again popularizing organic farming but bat guano is still not popular among the farming community since no explicit work on its plant growth promoting activity has been done. Hence the present study was undertaken to study the effect on the growth of *Vigna radiata* seedlings using *Megaderma lyra* guano from two different geographical locations (Yennehole and Varanga) in different quantities (soil: guano; 20:1, 20:0.5, 20:0.1) and in two types of soil (Autoclaved and Nonautoclaved).NPK content of guano was also analysed using standard techniques.

The results clearly indicated that the *M lyra* guano was rich in phosphorus content and comparing the guano from two locations the Varanga guano was found to be higher in its nitrogen content. Plant growth assay indicated that guano from Yennehole was found to be better as manure compared to that from Varanga. Likewise bat guano was required in a very small quantity to increase the efficiency of plant growth. Amendment of both types of soil with bat guano from both locations showed good growth at soil: guano ratio of 20:0.5.

Index Terms- Bat, Guano, *M. lyra*, NPK content, Plant growth, *Vigna radiata*

I. Introduction

In traditional India, the entire agriculture was practiced using organic techniques, where the fertilizers, pesticides were obtained from plant and animal products. Some of the commonly used organic fertilizers included are bovine dung and urine, sheep manure, poultry waste, chicken manure, night soil, composted agricultural wastes , bat guano, vermicompost . But due to the ever increasing population and so also the food demand, more lands were brought under cultivation, organic manure replaced by chemical fertilizers and locally made pesticides were replaced by chemical pesticides and the crop production increased. As time went by, extensive dependence on chemical farming has shown its darker side. The land is losing its fertility and is demanding larger quantities of fertilizers to be used. Pests are becoming immune requiring the farmers to use stronger pesticides. This in turn is posing great threat to the health of young population at large. In order to overcome the menace of chemical fertilizers and pesticides, modern India is once again reverting to the organic farming techniques and application of organic manure has been suggested (Mehdi et al.,2012; Michael et al., 2102; Naseer et al., 2003; Reddy et al., 1998).Application of vermicompost to improve soil fertility is becoming more popular but very little is known about the application of bat guano as organic manure(Sridhar et al, 2006). Bat guano is the feces of bats rich in carbon, nitrogen, vital minerals and of course beneficial microbes. Chemical properties and the microbes in the guano enrich the soil fertility and the texture and the microbes help to clear any toxins in the soil, control the fungi and nematodes in the soil. These properties of the guano again depend upon the bat species, location and age of the guano. Inspire of so many valuable properties, use of this rich manure has not gained any popularity among the farming community. Bat guano deposits have been found in several natural caves of the world and commercially exploited as natural manure (Bhat et al.,1990; Korine et al., 1999).Western countries promote and sale bat guano as manure some of which include Jamaica, Indonesia, Mexico but is not so in India. Since bat guano has ample of scope in agrobased industries and very few studies have explicitly measured its effects on plant growth, the present study was undertaken with two main objectives 1. to assess the impact of bat guano on the growth of mung bean, *Vigna radiata* and 2. to compare the effect of *M lyra* bat guano from two different geographical locations on the growth of *Vigna radiata.*

II. MATERIALS AND METHODS

Collection site- Two colonies of bat one dwelling in an abandoned house in Yennehole village and another in a Mutt in Varanga village of Karkala taluk of Udupi district, Karnataka, India respectively were used for collecting the guano. Both the colonies were of *Megaderma lyra* which is a semicarnivorous bat feeding on both insects and vertebrates like frogs and fishes (Bates and Harrison, 1997). Colony in Yennehole house comprise of 30-40 individual and this house is surrounded by coconut and arecanut plantations, paddy fields and small stretches of wood land. Those dwelling in Varanga Mutt comprise of 40-50 individuals and Mutt is surrounded by paddy fields, small lake, and Ghats. Droppings (guano) deposited beneath the roosting colony was collected for the plant growth study.

Chemical analysis of guano

The guano collected from two different locations were properly labeled upon collection. It was further analysed for its pH (Sridhar et al., 2006), total nitrogen (Sadasivam and Manickam, 2008), phosphorus and potassium (Baruah and Barthakur, 1997) content.

Plant growth study

To assess the impact of guano on plant growth black soil was collected from 30 cm depth. One half of the soil collected was autoclaved. 150g of each soil type (autoclaved and nonautoclaved) was mixed with guano in different ratios in plastic pots. The treatments included:

T1- autoclaved soil (control); T2-T4-autoclaved soil + Yennehole bat guano (20:1,20:0.5,20:0.1) respectively; T5-T6- autoclaved soil + Varanga bat guano (20:1, 20:0.5) respectively; T7-non- autoclaved soil (control); T8-T10- nonautoclaved soil + Yennehole bat guano (20:1,20:0.5,20:0.1) respectively;T11-T12 non-autoclaved soil + Varanga bat guano (20:1, 20:0.5) respectively. All the treatments were taken in triplicates. Guano from Varanga were studied with only two ratios due to shortage of sample at the roosting site. *Vigna radiata* seeds were used as test seeds to study the impact of guano on its growth. Seeds were soaked in tap water up to six hours. Water was drained and the seeds were allowed to germinate overnight on wet cloth. Five germinated green gram seeds were sown separately per treatment and allowed to grow in lab conditions. The pots were watered (sterile water) twice a day until harvest (10 days).On uprooting the seedlings shoot and root lengths were determined. Plants were oven dried at 80^{o}C until constant weight was obtained to determine the dry weight (biomass).

III. RESULTS

Guano properties.

The fecal pellets collected were blackish brown and grey around 9-11mm in size. Fecal pellets were elongated with rough surface, ends usually blunt , rarely pointed. Fecal pellets containing shiny insect bits (blackish brown) could be easily powdered whereas the pellets with vertebrate parts(greyish) were comparatively harder.

Chemical properties of guano

pH of *M lyra* guano from Yennehole was slightly alkaline(7.54) whereas that from Varanga was neutral(7.26).The NPK ratio of the guano 1:3:1 and 2:3:1 from Yennehole and Varanga respectively clearly indicated it is a phosphorus rich guano. However the nitrogen content is found to be higher in the guano collected from Varanga as shown in the figure 1

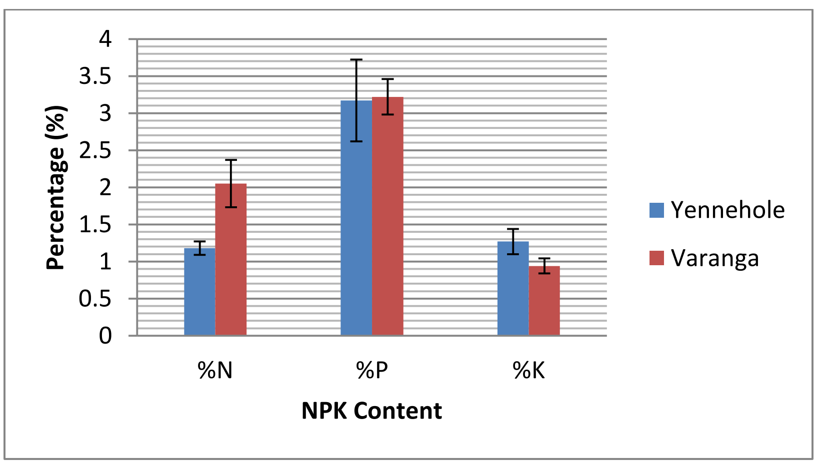

Fig. 1: NPK composition of *M lyra* guano from Yennehole and Varanga (n=6; mean±SE)

Plant growth assay

Growth parameters of *Vigna radiata* in terms of its root and shoot length and biomass using two types of bat guano in different ratios is given in the (fig:2-9).Soil amendment with bat guano from Yennehole(T2-T4 and T8-T10) gave better results than controls, T1 (autoclaved soil) and T7 (nonautoclaved soil). Also T3 (autoclaved soil+Yennehole bat guano,20:0.5) and T9 (nonautoclaved soil+ Yennehole bat guano,20:0.5) gave the best growth in shoot length and biomass. Soil amendment with guano from Varanga in only T6(autoclaved soil+ mutt bat guano,20:0.5) showed better shoot growth from control,T1 and the treatment T12 (nonautoclaved soil+ Varanga bat guano,20:0.5) showed similar growth as that of control,T7 . However the production of biomass in T6 and T12 was better than the controls T1 and T7 respectively. Autoclaved soil amended with bat guano showed better growth of *Vigna radiata* when compared to nonautoclaved soil.

Thus the application of bat guano showed significant growth differences from the control in both autoclaved and nonautoclaved soil.

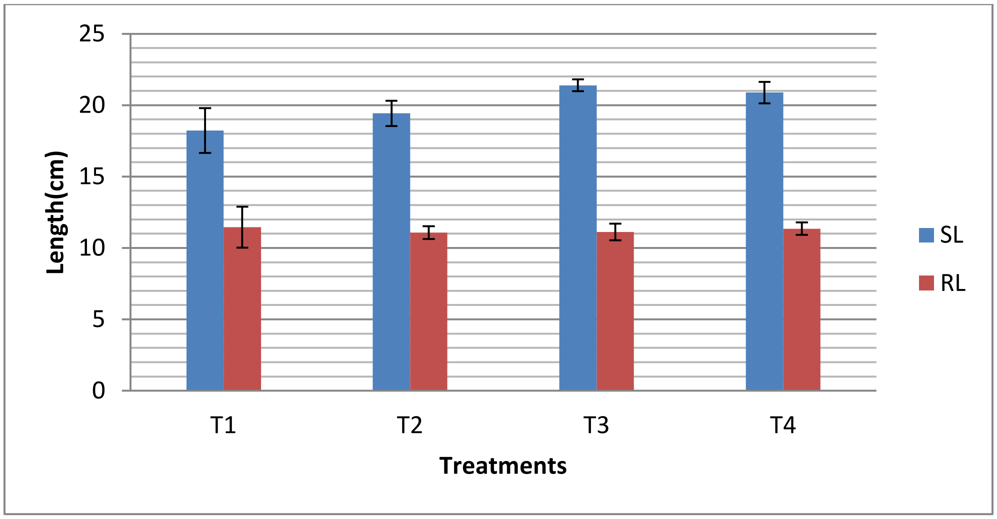

Fig. 2: Shoot length (SL) and Root length (RL) of seedlings in autoclaved soil +Yennehole guano. T1-autoclaved soil (control); T2-T4-autoclaved soil + Yennehole bat guano (20:1,20:0.5,20:0.1) (n=15:mean±SE).

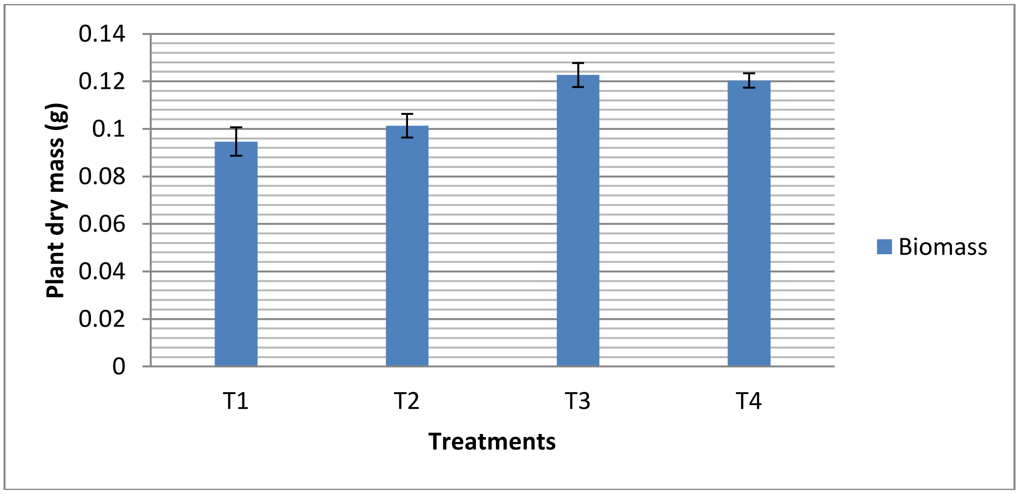

Fig. 3:Biomass of seedlings in autoclaved soil + Yennehole guano. T1-autoclaved soil (control); T2-T4-autoclaved soil + Yennehole bat guano (20:1,20:0.5,20:0.1) (n=3:mean±SE).

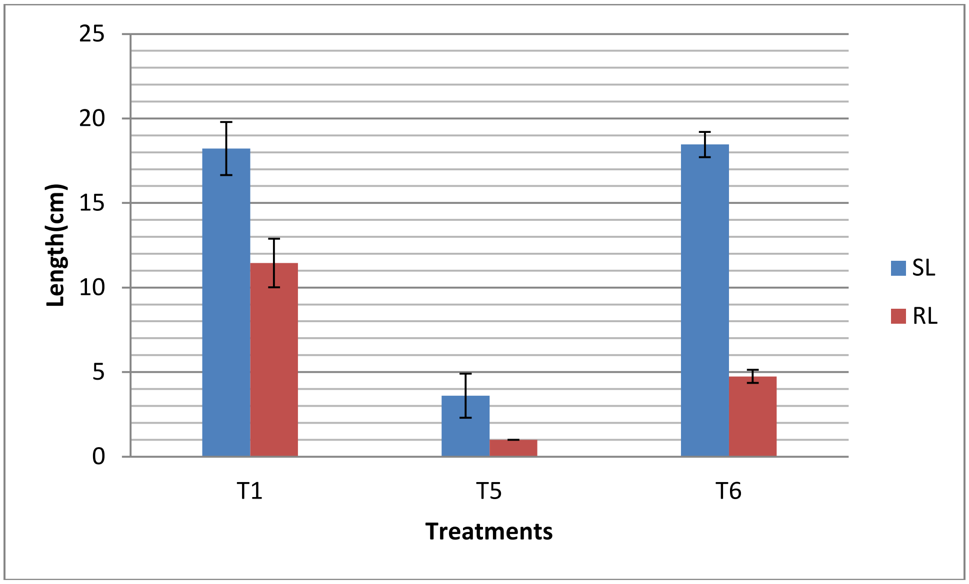

Fig. 4: Shoot length (SL) and Root length (RL) of seedlings in autoclaved soil +Varanga guano. T1-autoclaved soil (control); T5-T6-autoclaved soil + Varanga bat guano (20:1,20:0.5) (n=15:mean±SE).

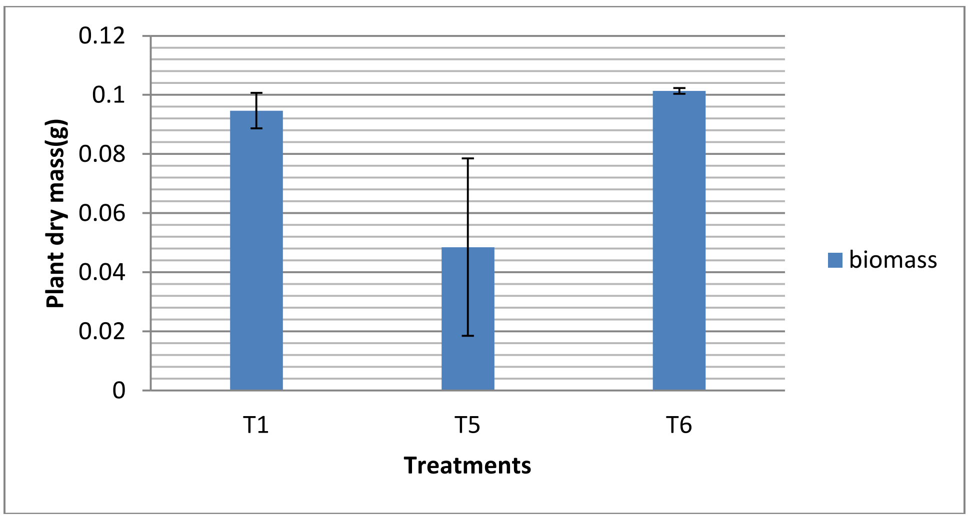

Fig. 5:Biomass of seedlings in autoclaved soil + Varanga guano. T1-autoclaved soil (control); T5-T6-autoclaved soil + Varanga bat guano (20:1,20:0.5,20) (n=3:mean±SE).

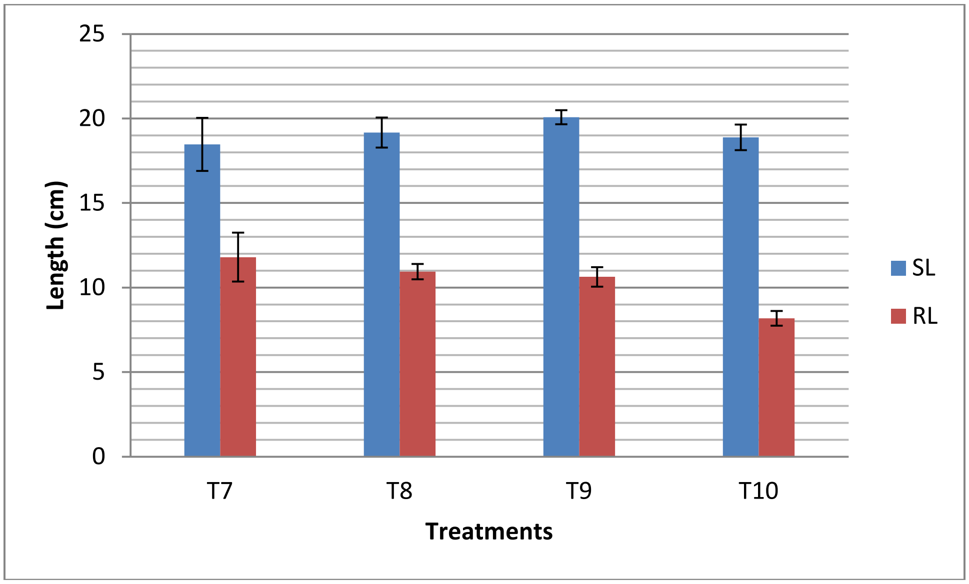

Fig. 6: Shoot length (SL) and Root length (RL) of seedlings in nonautoclavedsoil +Yennehole guano. T7-nonautoclaved soil (control); T8-T10-nonautoclaved soil + Yennehole bat guano (20:1,20:0.5,20:0.1) (n=15:mean±SE).

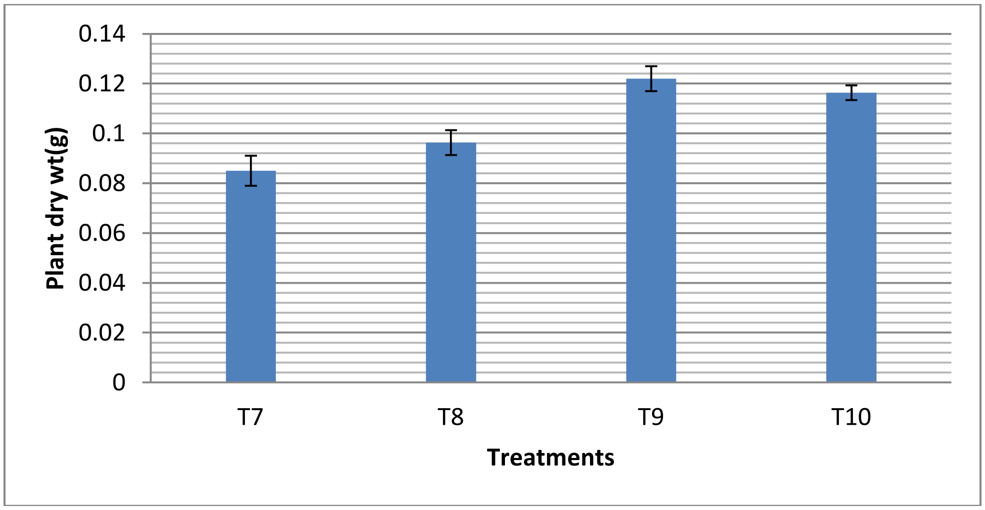

Fig. 7:Biomass of seedlings in nonautoclaved soil + Yennehole guano. T7-nonautoclaved soil (control); T8-T9-nonautoclaved soil + Yennehole bat guano (20:1,20:0.5,20:0.1) (n=3:mean±SE).

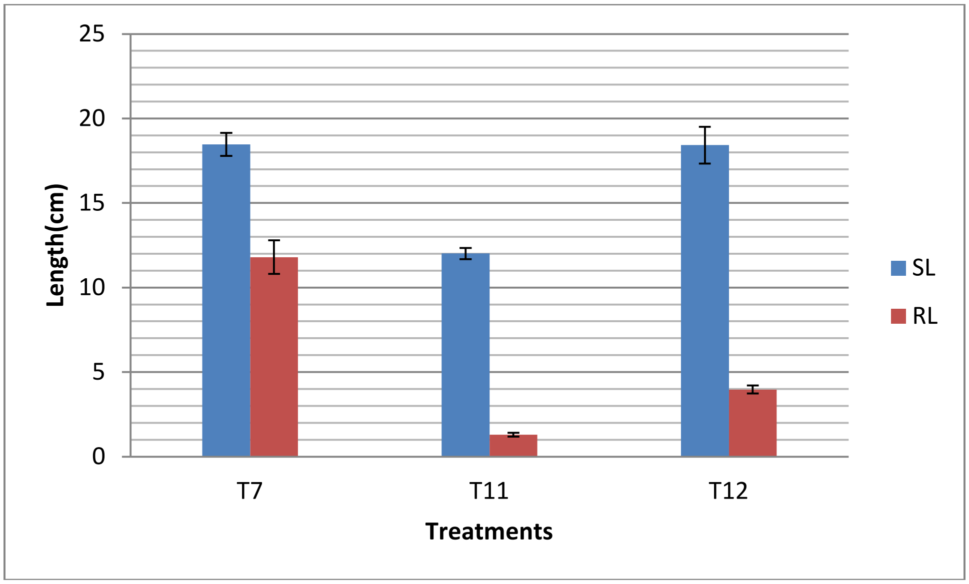

Fig. 8: Shoot length (SL) and Root length (RL) of seedlings in nonautoclavedsoil +Varanga guano. T7-nonautoclaved soil (control); T10-T11-nonautoclaved soil + Varanga bat guano (20:1,20:0.5) (n=15:mean±SE).

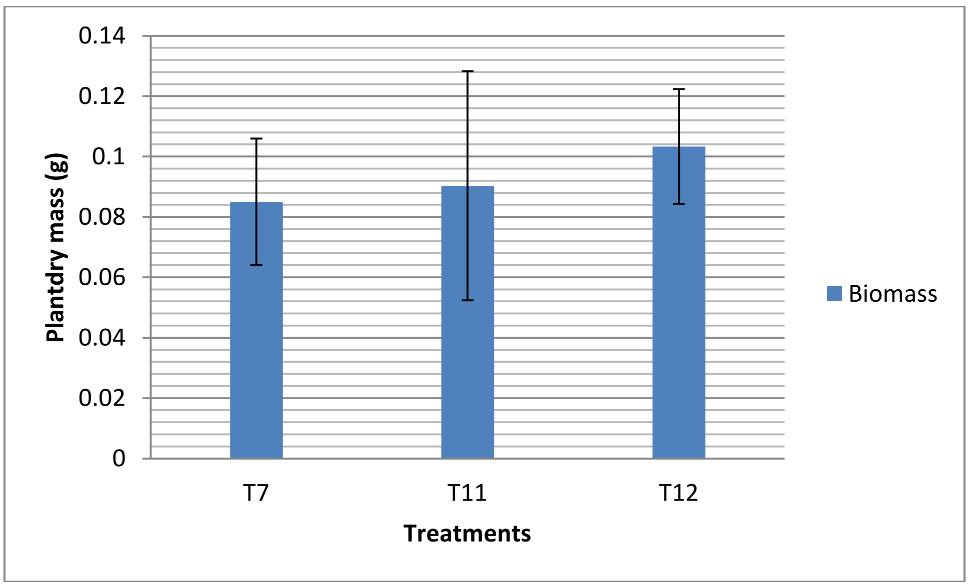

Fig. 9:Biomass of seedlings in nonautoclaved soil + Varanga guano. T7-nonautoclaved soil (control); T11-T12-nonautoclaved soil + Varanga bat guano (20:1,20:0.5) (n=3:mean±SE).

IV. DISCUSSION

Among the bat guano, two broad categories have been identified based on NPK ratios: high phosphorus guano (3:13:4- 4:30:4) from frugivorous bats and high nitrogen guano (8:4:1- 13:3:3) from insectivorous bats(Sridhar et al., 2006). *Megaderma lyra* being a semicarnivorous bats, the guano analysed in this study showed higher phosphorus levels than nitrogen. However the nitrogen content was higher in guano collected from Varanga than in Yennehole guano. Comparing this bat guano with other manures, guano has higher phosphorus and lower nitrogen content than chicken, sheep, goat, cow and pig manure (Olayiwola, 2011). Nitrogen rich manure enhances crop growth and phosphorus rich manure induces root development, shoot budding, branching and flowering. Hence bat guano can be mixed at various proportions with other high nitrogen organic manures for wholesome plant growth and soil fertility.

Guano from bats has long been mined from caves for use as fertilizer on agricultural crops due to its high concentrations of nitrogen and phosphorous, the primary limiting nutrients of most plant life(Pierson, 1998;Hutchinson, 1950). Reichard demonstrated that moderate applications of guano in a controlled greenhouse experiment promoted growth in a grass species native to Texas (Indian grass, *Sorghastrum nutans)*, but reduced root/stem ratio and had a neutral effect on two other native species: little bluestem, *Schizachyrium scoparium*, and prairie coneflowers, *Ratibida columnifera*, respectively. He further speculated that guano deposition may have species specific effects on plant communities(Reichard, 2010; Kunz et al., 2011). To add on, the present study also confirmed that the guano from same species of bat but from different geographical locations show difference in plant growth promoting properties possibly due to the differences in its microbial composition exerting a difference in the plant microbe interaction. Sridhar et al. in their studies on insectivorous bat guano on seedling growth of finger millet, *Eleusine coracana* and legume, *Phaseolus mungo* reported better growth, biomass and nitrogen content of the plants in soil amended with guano at 20:1 ratio. Also speculated that soil amendment with high quantities of guano resulted in wilting of seedlings. The present study was carried out at even lower quantities of soil : guano ratio (20:0.5, 20:0.1) indicating that guano is in fact needed to be incorporated at even lower quantities (20:0.5) for better crop production. It is also evident from the results that the bat guano in lower quantities increased the biomass significantly. Likewise amending the guano with farm yard manure in appropriate ratios may help overcome the nutrient deficiencies to improve crop production(Sridhar et. al., 2006)

In the present study the autoclaved soil was used with an idea of removing the soil microbes and study the plant growth effect of guano microbes. It was interesting to record that even the autoclaved soil amended with the bat guano showed best growth at soil: guano (20:0.5) ratio indicating that the bat guano contained plant growth promoting microbes along with requisite nutrients. Thus bat guano can be a promising source of biofertilizers due to their rich composition of nutrients and microbial flora.

V. SUMMARY AND CONCLUSION

The present study was conducted to study the effect on the growth of *Vigna radiata* seedlings using *M. lyra* guano from two different geographical locations (Yennehole and Varanga) in different quantities and in two type of soil (Autoclaved and Nonautoclaved).
The results clearly indicated that the *M lyra* guano is rich in phosphorus content and comparing the guano from two locations the Varanga guano is higher in its nitrogen content. Plant growth assay indicated that guano from Yennehole is better as manure compared to that from Varanga which may be possibly due to the differences in microflora of the guano. .Likewise bat guano is required in a very small quantity to increase the efficiency of plant growth. Although the guano obtained were from same species of bat *M. lyra* but the differences in their effects on plant growth is due to the differences in the microbial community that has a lot of influence on the growth promoting activity of the guano. Hence a better insight on guano microflora can give a better idea on these differences observed.

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AUTHORS

First author: ShrinidhiShetty, Department of Biotechnology, Alva's College, Moodbidri, -574 227 D.K. Karnataka,India.Email: *srimicrotech@yahoo.com*

Second author**:** K.S. Sreepada, Department of Applied Zoology, Mangalore University, Mangalagangothri - 574 199 D.K., Karnataka, India :Email: *sri_kpada@yahoo.co.in*

Third author: Rama Bhat, Department of Biotechnology, Alva's College, Moodbidri, -574 227 D.K. Karnataka,India. *bhat_pr@rediffmail.com*

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