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Research Article
Influence of Application of Inorganic Fertilizers and Animal Excreta on Growth and Yield Parameters of French Bean (*Phaseolus vulgaris* L.)

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Abstract

Background and Objectives: French bean has been observed as an important vegetable crop grown locally, which provides high nutrition, improves soil physical conditions and is utilized as fodder for livestock animals. The researcher aimed to observe the response of application of inorganic fertilizers in combination with types of decomposed animal excreta of animals such as sheep, goat and poultry on the growth and yield parameters of French bean. **Materials and Methods:** The research was conducted in a Randomized Complete Block Design (RCBD) with 3 replications of each treatment combinations comprised of 18 treatments i.e., 3 types of Decomposed Animal Excreta (DAE) such as poultry (DAEp), sheep (DAEs) and goat (DAEg) with 6 treatments levels. Treatment responses that had been observed were growth and yield components. The collected data were analyzed using Minitab statistical software. **Results:** It is obtained that application of FYM 10 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 100 kg ha^{-1} and Decomposed Animal Excreta of Poultry (DAEp) gave the maximum number of leaf, plant height, pod number, pod length, pod weight and French bean yield. This was followed by FYM 10 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 50 kg ha^{-1} and Decomposed Animal Excreta of Goat (DAEg). **Conclusion:** The application of treatment 5 comprises of FYM 10 MT ha^{-1}+200 kg NPK+100 kg urea ha^{-1} and Animal Excreta of Poultry (DAEp) increased the plant height, leaf number, pod number, pod weight and yield of French bean.

Key words: French bean decomposed animal excreta, plant height, number of leaves, pod number, pod weight, pod length and yield

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

French bean is a member of the legume family Fabaceae which is native to America and grown worldwide. French bean is an important vegetable crop grown extensively due to its short duration and high nutritive values which provides a lot of opportunities to local farmers to diversify the risk and export the produce[1]. The crop is known by various local names such as kidney bean, green bean, "*bini*" etc. and is a good source of protein, calcium, phosphorus, iron, carotene, thiamine, riboflavin and vitamin A and C. *Phaseolus vulgaris* are nutritionally and economically important food crop in each part of the world for human diet and offers a wide range of important minerals[2,3]. Inappropriate cultivation practices and long term application of inorganic fertilizers without organic supplements gave poor soil physicochemical properties, environmental degradation and low productivity of crops[4]. Low productivity is attributed to low fertility, poor soil organic matter content due to inadequate supply of organic materials. Substitution of plant nutrient elements by organic means is very important for sustainable agriculture production. Although, inorganic fertilizers are a convenient way for rapid correction of nutrient deficiencies but reduce overall soil fertility[5], their high cost limits its wide application by farmers[6]. Application of organic-based fertilizers can result in higher soil microbial activity and fertility, whereas chemical forms of fertilizers with higher salt effects generally reduce soil microbial activity and soil fertility[7]. Farmyard manure improves the physical and chemical properties of soil[8] and acts as the source of plant nutrients and organic matter, which enhance the soil biodiversity[9] and improve the soil quality[10]. The advantage of combining organic and inorganic sources of nutrients in nutrient management has been proved superior to the use of each component separately. In modern-day intensive crops, cultivation requires the use of chemical fertilizers but the price of inorganic fertilizers increasing day by day which in turn has increased the cost of production. The use of inorganic fertilizers not only increased the cost of production but also decreased the overall soil fertility causing environmental pollution[11]. Use of organic materials[12] as an effective means for improving biological and physical properties of soil which results in higher moisture availability, better nutrient retention and increased crop yield. Research outcomes[13] in Fiji demonstrated a low level of soil organic matter and major plant nutrients such as nitrogen, phosphorus etc. Many previous studies pointed out that the application of both chemical and organic fertilizers together caused to improve soil properties and supply of essential plant nutrients for higher yield[14,15]. Recently, Kobobe[16] observed that the combined application of FYM and nitrogen fertilizers significantly influenced the plant height, number of leaves and total yield of onion. Therefore, this study aimed to explore the appropriate chemical fertilizer doses in combination with naturally decomposed animal excreta application to achieve potential crop production and soil improvement.

MATERIALS AND METHODS

Study area: The study was carried out during April-August, 2016 at the Instructional Agricultural-Farm Complex (IAFC), College of Agriculture, Fisheries and Forestry (CAFF), Fiji National University, Fiji. The geographical location of the study area is S18°2'33"-E178°32'45". The soil type of the experimental fields was sandy clay loam to clay loam in texture, organic matter content is quiet low (1.9%) and soil pH is 5.8. Research fields are approximately 15 m above mean sea level and fields are poorly drained[13]. The study area has a warm tropical climate characterized by heavy rainfall during November-April and scanty rainfall during the rest of the year. The annual precipitation of the site was 3500 mm. The average maximum temperature was 26°C and the average minimum temperature was 21°C. The average mean temperature was 23°C. The humidity was varied from 71.5-81.0%[17].

Treatments: The experiment comprised of 18 treatments i.e., 3 different Decomposed Animal Excreta (DAE) such as poultry (DAEp), sheep (DAEs) and goat (DAEg) with 6 treatment levels as shown in Table 1. Decomposed animal excreta were added into the experimental plots before secondary tillage. Chemical fertilizer was added according to the plant growth stage as recommended according to plant variety.

Plants were planted at a standard spacing of 50 and 30 cm between the rows and plants, gap-filling; weeding, irrigation and pest management were done as per the requirement.

Table 1: Treatment combinations

Treatments	Treatment composition
T_1	FYM 5 MT ha^{-1}
T_2	FYM 5 MT ha^{-1} + NPK 100 kg ha^{-1}
T_3	FYM 5 MT ha^{-1} + NPK 200 kg ha^{-1}+urea 50 kg ha^{-1}
T_4	FYM 10 MT ha^{-1} + NPK 200 kg ha^{-1}+urea 50 kg ha^{-1}
T_5	FYM 10 MT ha^{-1} + NPK 200 kg ha^{-1}+urea 100 kg ha^{-1}
T_6	FYM 5 MT ha^{-1} + urea 50 kg ha^{-1}

FYM: Farm yard manure, MT ha^{-1}: Metric ton per hectare, kg ha^{-1}: Kilogram per hectare, NPK: Nitrogen, phosphorus and potassium mixture

Experiment design: The experiment was designed as Randomized Complete Block Design (RCBD) with three replications of each treatment combination. As treatment responses plant height, number of leaves, number of pods; seeds per pod, pod length, pod weight and final yield were recorded. Three plants from each replication were selected randomly and were tagged for the data collection.

Statistical analysis: The collected data were statistically analyzed using Minitab statistical software. Analysis of Variance (ANOVA) on Randomized Complete Block Design by General Linear Model (GLM) procedure was performed and treatments means were analyzed by least significant different test method[18].

RESULTS

Figure 1 shows the final yield value of French beans for the different treatments. It was clear that treatment 5 with FYM as DAEp was given the highest yield followed by treatment 4 with FYM as DAEp was given the second-highest yield. The minimum yield was given treatment 1 i.e., application of FYM only and application of DAEs. Higher yield showed to DAEp treatment and DAEs gave the lower yield records. These results revealed that Decomposed Animal Excreta (DAE) poultry given required nutrients for better growth of the plants in comparison to other decomposed animal excreta such as goat and sheep. French bean is belonging to the leguminous family, therefore, this plant may be required more nitrogen fertilizer than other nutrient components, therefore, the plant might be given a higher yield to DAEp with higher urea (treatment 5 with FYM as DAEp).

Number of leaves and plant height: Table 2 and 3 show the results of the least significant difference test. Results revealed that the average number of leaves and plant height increased significantly with an increase in treatment levels up to treatment 5 (T_5). The maximum average number of leaves (22.4) and plant height (47.6 cm) were recorded with T_5 which was followed by T_4. The lowest average number of leaves (14.6) and plant height (39.9 cm) were observed with T_1. Results (Table 2) indicates that the average number of leaves and plant height were maximum in the case of DAEp (decomposed animal excreta of poultry) followed by DAEg (goat) and minimum in case of DAEs (sheep). The highest average number of leaves (21.0) and plant height (46.8 cm) was observed with DAEp, which was significantly higher with other treatments. The lowest average number of leaves (17.5) and plant height (41.0 cm) was observed in the case of DAEs.

Number of pods and pod length: Data showed that the average number of pods per plant and pod weight was increased significantly with an increase in treatments (Table 2) up to T_5. The maximum average number of pods (20.9) per plant and average pod length (12.2 cm) were recorded with T_5, which was followed by T_4. The maximum value was observed with T_5 which were statistically similar to T_4 in the case of the number of pods (20.5 per plant) and pod length (11.8 cm). The minimum values of the average number of pods (13.7) per plant and pod length (6.9 cm) were recorded with Treatment 1 (T_1).

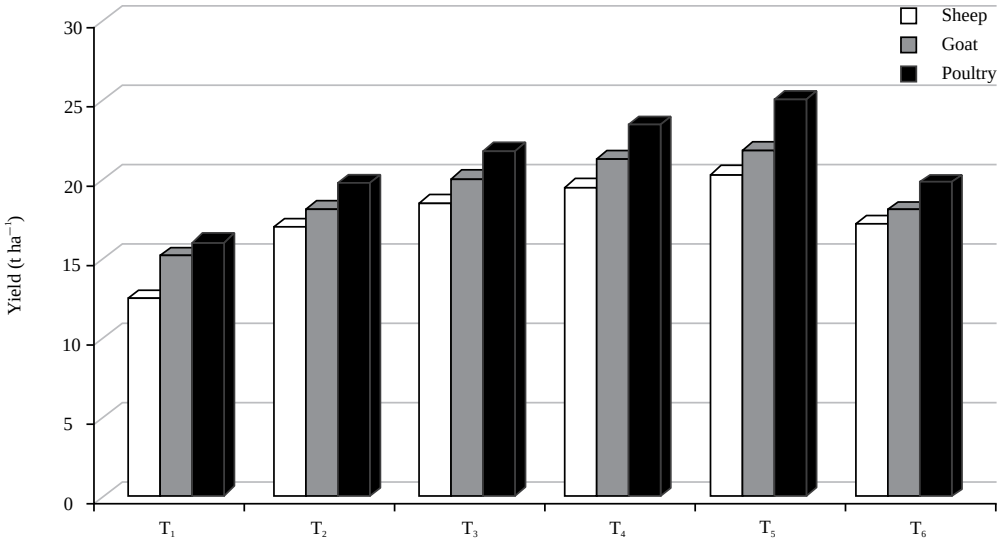

Fig. 1: Treatments response for the yield of French bean

Table 2: Average of number of leaves, plant height, number of pods and pod length

Treatments	No. of leaf/plant	Plant height (cm)	No. of pods/plant	Pod length (cm)
FYM 5 MT ha^{-1} (T_1)	14.6^{e}	39.9^{e}	13.7	6.9^{d}
FYM 5 MT ha^{-1}+NPK 100 kg ha^{-1} (T_2)	18.3^{d}	42.9^{d}	16.3^{c}	8.9^{c}
FYM 5 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 50 kg ha^{-1} (T_3)	20.1^{c}	45.0^{c}	18.8^{b}	10.3^{b}
FYM 10 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 50 kg ha^{-1} (T_4)	21.4^{b}	46.6^{b}	20.5^{ab}	11.8^{ab}
FYM 10 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 100 kg ha^{-1} (T_5)	22.4^{a}	47.6^{a}	20.9^{a}	12.2^{a}
FYM 5 MT ha^{-1}+urea 50 kg ha^{-1} (T_6)	18.4^{d}	42.5^{d}	16.6^{c}	9.0^{c}
Critical difference at 5%	0.6	0.9	0.5	0.4
Decomposed Animal Excreta of Poultry (DAEp)	21.0^{a}	46.8^{a}	19.5^{a}	10.6^{a}
Decomposed Animal Excreta of Sheep (DAEs)	17.5^{c}	41.0^{c}	16.1^{c}	9.1^{c}
Decomposed Animal Excreta of Goat (DAEg)	19.1^{b}	44.4^{b}	17.9^{b}	9.9^{b}
Critical difference at 5%	0.4	0.6	0.3	0.3

Numbers followed by the same letter in the same column show no significant difference ($p \leq 0.05$)

Table 3: Average of pod weigh, seed per pod and yield of French bean

Treatments	Pod weight (g)	Seeds/pod	Yield (t ha^{-1})
FYM 5 MT ha^{-1} (T_1)	5.1^{e}	4.2^{d}	5.6^{e}
FYM 5 MT ha^{-1}+NPK 100 kg ha^{-1} (T_2)	6.3^{d}	5.7^{c}	8.2^{d}
FYM 5 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 50 kg ha^{-1} (T_3)	7.1^{c}	6.5^{b}	10.8^{c}
FYM 10 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 50 kg ha^{-1} (T_4)	8.0^{b}	7.2^{ab}	13.2^{b}
FYM 10 MT ha^{-1}+NPK 200 kg ha^{-1}+urea 100 kg ha^{-1} (T_5)	8.8^{a}	7.4^{a}	14.9^{a}
FYM 5 MT ha^{-1}+urea 50 kg ha^{-1} (T_6)	6.3^{d}	5.5^{c}	8.5^{d}
Critical difference at 5%	0.5	0.3	0.8
Decomposed Animal Excreta of Poultry (DAEp)	7.3^{a}	6.4^{a}	11.7^{a}
Decomposed Animal Excreta of Sheep (DAEs)	6.5^{c}	5.7^{c}	8.6^{c}
Decomposed Animal Excreta of Goat (DAEg)	7.0^{b}	6.1^{b}	10.3^{b}
Critical difference at 5%	0.4	0.2	0.6

Numbers followed by the same letter in the same column show no significant difference ($p \leq 0.05$)

Observed results revealed that the average number of pods per plant and pod length was maximum with the application of DAEp (poultry manure) followed by DAEg (goat) and minimum in case of DAEs (sheep). The highest number of pods (19.5) per plant and pod length (10.6 cm) was observed with DAEp which was significantly higher with other treatments. The lowest values of the number of pods (16.1) per plant and pod length (9.1 cm) were recorded with DAEs.

Pod weight and seeds per pod: The pod length and number of seeds per pod (Table 3) were increased with an increase in treatments levels up to T_5. The highest values of pod weight (8.8 g) and the number of seeds (7.4 per pod) were observed with T_5, which was followed by T_4. However, the observed number of seeds with T_5 was statistically similar to T_4 (7.2 per pod). The lowest pod length (5.1 g) and the number of seeds (4.2 per pod) with T_1. Similarly, the Decomposed Animal Excreta of Poultry (DAEp) recorded the highest value of the pod weight (7.3 g) and the number of seeds (6.4 per pod) followed by DAEg and minimum pod weight (6.5 g) and the number of seeds (5.7 per pod) was recorded with the application of DAEs.

Yield: The maximum yield of the French bean was recorded with the application of T_5 treatment, which was followed by T_4, whereas, the minimum yield was recorded with T_1. The maximum French bean yield (14.9 t ha^{-1}) was recorded with T_5, which was followed by T_4 (13.2 t ha^{-1}) and the minimum yield (5.6 t ha^{-1}) with the application of T_1. On the other hand, DAE prerecorded the highest yield (11.7 t ha^{-1}), which was followed by DAEg and minimum (8.6 t ha^{-1}) yield were recorded with the application of DAEs.

DISCUSSION

In the present study the leaf number, plant height, pod weight and French bean yield increased with the application of treatment 5 (i.e., NPK 200+urea 100 kg ha^{-1}) with 10 MT FYM ha^{-1} as Decomposed Animal Excreta of Poultry (DAEp), which was significantly higher with other treatments. Increased growth parameters might have been obtained due to better growth and leaf expansion due to developed photosynthetic capacity[19] and enhanced effective utilization of plant nutrients[20] due to application of poultry manure with urea and NPK fertilizer, which contributed an increase in the yield components. The higher pod number and pod length

could be the result of improvement in soil fertility due to an increase in soil organic material which enhanced the function of chemical fertilizer[21], as manure makes the inorganic N less easy to leach. Nath *et al.*[22] observed that application of composted animal excreta of livestock animals, which contain a high level of SOM, OC, total and available NPK and micronutrients, significantly increased the yield of tomato, microbial and enzymatic[23-25]. Application of decomposed animal manures increased the plant height and fresh biomass of alfalfa and vincarosa[26] plants. The findings are similar to Sutrisno and Yusnawan[27], who reported on the growth and yield of mung bean and Kulkarni *et al.*[28] on groundnut. Maria *et al.*[29] revealed that the application of animal manures in the combination of inorganic fertilizers increased the plant growth, yield, pod and vegetable soybean forage feed. Faisal *et al.*[30] observed that the application of organic and inorganic manures improves the maize yield and physio-chemical properties of soil. Amin *et al.*[31] reported an increase in growth, yield and quality of Fodder Maize by application of a different source of nitrogen. Singh *et al.*[32], reported that an increase in growth and yield parameters of French bean was due to the combined application of organic manure and inorganic fertilizer under irrigated conditions. Application of decomposed animal excreta in combination with fertilizer doses might have improved the physical, chemical and biological properties[33] of soil and helped for better plant growth and higher yield. These findings are also supported by Adeniyan and Ojeniyi[34], Sarma *et al.*[35] and Mohanty *et al.*[36].

The additional increase in the application of urea did not affect the growth and yield of French beans after doses of 50 kg ha^{-1}. The major limitation observed during the study was frequent and unpredicted rainfall. It would be recommended to carry out similar studies across the region to identify the appropriate fertilizers and manures doses for efficient utilization of available resources.

CONCLUSION

The result of the study revealed that maximum plant height; the number of leaves, pod weight, seeds per pod was recorded in T_5 and T_4 with DAEp and minimum recorded in T_1 with any types of animal FYM. The maximum yield was recorded with DAEp followed by DAEg and minimum with DAEs and the higher performance of composted animal excreta on the growth of the French bean might be due to the release of the optimum amount of plant nutrients as well as the slow release over an extended period. Finally, it can be concluded that inorganic fertilizer together with organic farm animal decomposed animal excreta gave good results in terms of plant growth and yield. Further, it caused higher improvement of soil texture and structure than adding inorganic fertilizer along.

SIGNIFICANCE STATEMENT

This study will help the farmers to determine the application of appropriate doses of fertilizers in combination with manures to maximize the crop yield and to improve the soil physical conditions, at the same time to the researchers to explore such identified areas to explore the possibility of further research in the region for to uncover the ways for sustainable crop production.

REFERENCES

1. Feliciano, D., 2019. A review on the contribution of crop diversification to sustainable development Goal 1 "no poverty" in different world regions. Sustainable Dev., 27: 795-808.
2. Augustin, J., C.B. Beck, G. Kalbfleish, L.C. Kagel and R.H. Matthews, 1981. Variation in the vitamin and mineral content of raw and cooked commercial *Phaseolus vulgaris* classes. J. Food Sci., 46: 1701-1706.
3. Hayat, I., A. Ahmad, T. Masud, A. Ahmed and S. Bashir, 2014. Nutritional and health perspectives of beans (*Phaseolus vulgaris* L.): An Overview. Crit. Rev. Food Sci. Nutr., 54: 580-592.
4. Vitalis, V., 2007. Agricultural subsidy reform and its implications for sustainable development: the New Zealand experience. Environ. Sci., 4: 21-40.
5. Barcchiya, J. and S.S. Kushwah, 2017. Influence of integrated nutrient management on growth, yield parameters and yield in French bean (*Phaseolus vulgaris* L.). Legume Res. Int. J., 40: 920-923.
6. Ibijbijen, J., S. Urquiaga, M. Ismaili, B.J.R. Alves and R.M. Boddey, 1996. Effect of arbuscular mycorrhizal fungi on growth, mineral nutrition and nitrogen fixation of three varieties of common beans (*Phaseolus vulgaris*). New Phytol., 134: 353-360.
7. Eisa, S.A.I., 2011. Effect of amendments, humic and amino acids on increases soils fertility, yields and seeds quality of peanut and sesame on sandy soils. Res. J. Agric. Biol. Sci., 7: 115-125.
8. Bayu, W., N.F.G. Rethman, P.S. Hammes and G. Alemu, 2006. Effects of farmyard manure and inorganic fertilizers on sorghum growth, yield and nitrogen use in a semi-arid area of Ethiopia. J. Plant Nutr., 29: 391-407.
9. Albiach, R., R. Canet, F. Pomares and F. Ingelmo, 2000. Microbial biomass content and enzymatic activities after the application of organic amendments to a horticultural soil. Bioresour. Technol., 75: 43-48.

10. Zaman, M.M., M.A. Rahman, T. Chowdhury and M.A.H. Chowdhury, 2018. Effects of combined application of chemical fertilizer and vermicompost on soil fertility, leaf yield and stevioside content of stevia. J. Bangladesh Agric. Uni., 16: 73-81.
11. Ramana, V., M. Ramakrishna, K. Purushotham and K.B. Reddy, 2010. Effect of bio-fertilizers on growth, yield attributes and yield of french bean. Veg. Sci., 38: 35-38.
12. Marinari, S., G. Masciandaro, B. Ceccanti and S. Grero, 2000. Influence of organic and mineral fertilizers on soil biological and physical properties. Bioresour. Technol., 72: 9-17.
13. Singh, I.R., A.C. Sharma and S.N. Goswami, 2013. Nutrient status and their availability in relation to properties of soils of koronivia, Fiji. Fiji Agric. J., 53: 1-6.
14. Das, B., A.P. Wagh, V.N. Dod, P.K. Nagre and S.O. Bawkar, 2011. Effect of integrated nutrient management on cowpea. Asian J. Hortic., 6: 402-405.
15. Metkari, P.M. and S.P. Dhok, 2011. Effect of organic and inorganic fertilization on soil fertility and productivity of French bean in Vertisol. Asian J. Soil Sci., 6: 80-84.
16. Yohannes, K.W., D. Belew and A. Debela, 2013. Effect of farmyard manure and nitrogen fertilizer rates on growth, yield and yield components of onion (*Allium cepa* L.) at Jimma, Southwest Ethiopia. Asian J. Plant Sci., 12: 228-234.
17. Singh, I.R., 2016. Micronutrient level in relation to other soil properties of Koronivia, Fiji. Asian J. Soil Sci., 11: 155-158.
18. Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd Edn., John Wiley and Sons Inc., New York, USA., Pages: 704.
19. Otieno, P.E., J.W. Muthomi, G.N. Chemining'wa and J.H. Nderitu, 2009. Effect of rhizobia inoculation, farm yard manure and nitrogen fertilizer on nodulation and yield of food grain legumes. J. Biol. Sci., 9: 326-332.
20. Caliskan, S., I. Ozkaya, M.E. Caliskan and M. Arslan, 2008. The effects of nitrogen and iron fertilization on growth, yield and fertilizer use efficiency of soybean in a Mediterranean-type soil. Field Crops Res., 108: 126-132.
21. Banu, S.S., A. Arjumand, B. Nag and E.T. Puttaiah, 2013. Effectiveness of farm yard manure, poultry manure and fertilizer –NPK on the growth parameters of french bean (*Phaseolus vulgaris*) in Shimoga, Karnataka. Global J. Curr. Res., 1: 31-35.
22. Nath, P., I.R. Singh and I. Tuitubou, 2017. Effect of application of excreta of livestock animals and methods of their decomposition on the growth parameters of tomato (*Lycopersicum esculentum* L.). Int. J. Agric. Sci., 13: 271-275.
23. Edwards, C.A. and P.J. Bohlen, 1996. Biology and Ecology of Earthworms. 3rd Edn., Chapman and Hall, London, UK., ISBN-13: 9780412561603, Pages: 426.
24. Ranganathan, L.S., 2006. Vermibiotechnology-From Soil Health to Human Health. Agrobios, Jodhpur, India, ISBN-13: 9788177542943 Pages: 154.
25. Parthasarathi, K., L.S. Ranganathan, V. Anandi and J. Zeyer, 2007. Diversity of microflora in the gut and casts of tropical composting earthworms reared on different substrates. J. Environ. Biol., 28: 87-97.
26. Alwaneen, W.S., 2016. Effect of cow manure vermicompost on some growth parameters of alfalfa and *Vinca rosa* plants. Asian J. Plant. Sci., 15: 81-85.
27. Sutrisno and E. Yusnawan, 2018. Effect of manure and inorganic fertilizer on vegetative generative characteristic nutrient and secondary metabolit content of mungbean. Biosaintifik, 10: 56-65.
28. Kulkarni, M.V., K.C. Patel, D.D. Patil and M. Pathak, 2018. Effect of organic and inorganic fertilizers on yield and yield attributes of groundnut and wheat. Int. J. Chem. Stud., 6: 87-90.
29. Darini, M.T., S. Widata and W.S. Ratri, 2020. Response of vegetable soybean (*Glycin max* L. Merr.) Plant by application of integrated fertilizers in volcanic soil. Asian J. Plant Sci., 19: 246-251.
30. Mahmood, F., I. Khan, U. Ashraf, T. Shahzad and S. Hussain *et al*., 2017. Effects of organic and inorganic manures on maize and their residual impact on soil physico-chemical properties. J. Soil Sci. Plant Nutr., Vol. 17. 10.4067/s0718-95162017005000002.
31. Amin, M.E.M.H., 2011. Effect of different nitrogen sources on growth, yield and quality of fodder maize (*Zea mays* L.). J. Saudi Soc. Agric. Sci., 10: 17-23.
32. Singh, N.I. and J.S. Chauhan, 2009. Response of frenchbean (*Phaseolus vulgaris* L.) to organic manure and inorganic fertilizer on growth and yield parameters under irrigated condition. Nat. Sci., 7: 52-54.
33. Singh, B., K. Pathak, A. Verma, V. Verma and B. Deka, 2011. Effects of vermicompost, fertilizer and mulch on plant growth, nodulation and pod yield of French bean (*Phaseolus vulgaris* L.). Vegetable Crops Res. Bull., 74: 153-165.
34. Adeniyan, O.N. and S.O. Ojeniyi, 2005. Comparative effectiveness of different levels of poultry manure with NPK fertilizer on residual soil fertility, nutrient uptake and yield of maize. Moor J. Agric. Res., 4: 191-197.
35. Sarma, I., M. Phukon, R. Borgohain, J. Goswami and M. Neog, 2014. Response of french bean (*Phaseolus vulgaris* L.) to organic manure, vermicompost and biofertilizers on growth parameters and yield. Asian J. Hortic., 9: 386-389.
36. Mohanty, S., G.S. Sahu, S.K. Dash, S.R. Pradhan, S. Mangaraj and S. Nahak, 2017. Integrated nutrient management for seed production in french bean [*Phaseolus vulgaris* (L.)]. Int. J. Curr. Microbiol. Appl. Sci., 6: 3295-3303.