International Journal of Plant Science and Ecology
Vol. 1, No. 5, 2015, pp. 213-217
http://www.aiscience.org/journal/ijpse

Effect of Dump Site Soil on the Growth of Common Bean (*Phaseolus vulgaris*)

Osuagwu G. G. E.[1, *], Nwokeocha O. W.[1], Mgbeze G. C.[2], Ini O. O.[1]

[1]Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Umuahia Abia State, Nigeria
[2]Department of Plant Biology and Biotechnology, University of Benin, Benin City, Edo State Nigeria

Abstract

The effect of dump site soil on the growth characteristics of *Phaseolus vulgaris* plant, its proximate composition and anti-nutritional factor of the seeds were examined. All the growth parameters studied showed a positive increase as the dump site soil proportion increased. The result of the proximate composition revealed that an increase in the dump site soil proportion caused an increase in the moisture, ash, crude fibre, fat and protein content while the carbohydrate content decreased. The result of the anti-nutritional content revealed an increase in the tannin content, phytate, oxalate, cyanide, and trypsin inhibitor.

Keywords

Dump Site, Soil, Common Bean, Effect, Growth

Received: July 2, 2015 / Accepted: July 11, 2015 / Published online: July 28, 2015

1. Introduction

The use of residue from human consumption, agricultural activities, and municipal waste can improve soil physical and chemical properties and also the fertility and production (Sposito, 1982). Compost represent an important resource to maintain and restore soil fertility and are of great value nowadays, particularly in those countries where the organic matter content of the soil is low (Castaldi *et al.*, 2004). Soil organic matter plays a major role in maintaining soil quality (Pedra *et al.*, 2007). In addition to supplying plant nutrients, the type and amount of soil organic matter influences several soil properties (Arau'jo *et al.*, 2008). Nevertheless, the application of composted waste to agricultural soils requires caution due to the possibility of food chain contamination and negative effects on soil microbiology, particularly rhizobia (Singh and Agrawal, 2009).

The common bean (*Phaseolus vulgaris* L.) is a herbaceous plant that belong to the family of *Fabeceae.* Over 30 species of *Phaseolus* have reported from the Americas (Debouck, 1991) and out of these only five namely common bean (*Phaseolus vulgaris* L.), year bean (*Phaseolus polyanthus*), scarlet runner bean (*Phaseolus coccineus* L.), tepary bean (*Phaseolus acutifolius* A, Gray) and lima bean (*P. lunatus* L.) are known to be domesticated (Gepts and Debouck, 1991). The plant originated from the western area of Mexico and Guatemala. It is widely cultivated and distributed from Mexico to the southern ends of the southern Andes (Voysest and Fernandez, 1986). It is widely consumed throughout the world (Juhi *et al.,* 2010). Common bean is one of the staple food in Africa, India, and Latin America. It is an important source of dietary proteins for both human and animals, but for the presence of high concentration of toxins such as phytate, tannins and oxalate referred to anti-nutritive factors that affect the nutritional quality by interacting with intestinal tract and also reduce protein digestibility and amino acid absorption (Nowacki, 1980). According to Liener (1994), unless these substances are destroyed by heat or other treatments, they can exert adverse physiological effects when utilized by animals and man. Common bean is a legume considered as a functional food because it contains bioactive phytochemicals such as polyphenols and tannins which show antioxidant capacity (Duenas *et al.,* 2005; Oomah *et al.,* 2005).

* Corresponding author
E-mail address: gbekus2002@yahoo.com (Osuagwu G. G. E.)

2. Materials and Methods

The study was conducted in the premises of Michael Okpara University of Agriculture, (M.O.U.A) Umudike. Umudike is in the rainforest belt of Nigeria and lies on latitude 05˚ 28'N and longitude 07˚ 32'E. It has an average rainfall of 2,200mm and is 123 meters above sea level. Minimum and maximum temperatures are 22.41˚C and 30˚C respectively, with total annual mean rainfall of 1,245.3 mm (N.R.C.R.I Meteorological Report, 1983). The seeds used for the studied where gotten from the seed unit of National Root Crop Research Institute, (N.R.C.R.I) Umudike, while the dump site soil and top soil were collected from the dump site of MOUAU and the university demonstration farm respectively. The seeds were planted in plastic buckets in which the soils where poured at different proportions. There were four (4) different dump site to top soil proportions used for the study; T_1 (25% dump site soil and 75% top soil), T_2 (50% dump site soil and 50% to soil), T_3 (75% dump site soil and 25% top soil), T_4 (100% dump site soil and 0% top soil) and Control (0% dump site soil and 100% top soil). Seven (7) seeds of *P. vulgaris* were sown on each of the plastic bucket after which it was thinned down to three (3), four weeks after germination. The parameters taken into consideration and measured periodically were the height of plant, number of flowers, number of pods, number of leaves, number of seeds per pod and 100 seed weight. The seeds which were gotten from the matured plants were analyzed to determine their proximate and anti-nutrient content respectively. Data obtained were subjected to one way analysis of variance (ANOVA) using SPSS version 20. The mean differences were separated using Duncan's multiple range test (DMRT) at 5% confidence level.

3. Results

The result in table 1 shows the composition of dump site and top soils respectively. This result was use to compare the various constituents of both soils to establish which had more composite compared to the other. Tables 2-6 summarized the effect of dump site soil on the vegetative and reproductive growth as well as proximate and anti-nutrient contents of *P. vulgaris*.

Table 1. Composition of Dump site and top soil.

	Dump site Soil	Top Soil
Sand (%)	73.80	71.80
Silt (%)	12.80	14.80
Clay (%)	13.40	13.40
Texture	Sandy-loam	Sandy-loam
pH	5.99	5.97
P	39.10	38.50
N	0.29	0.28
OC	2.16	2.27
OM	3.92	3.91
CA	8.80	8.80
Mg	4.00	3.60
K	0.19	0.18
NA	0.14	0.13
EA	1.80	1.76
LqCq	14.94	14.47
%B5	87.94	87.86

Table 2. Effect of Dump site soil on the Plant height of *P.vulgaris*.

Treatments	WK 2	WK 4	WK 6	WK 8
Control (0%)	31.50 ± 5.29^{bc}	49.33 ± 5.51^{e}	69.83 ± 8.25^{cd}	77.00 ± 12.82^{d}
T_1	31.60 ± 3.35^{bc}	62.57 ± 7.82^{d}	77.33 ± 37.12^{c}	84.00 ± 45.94^{c}
T_2	32.00 ± 3.35^{c}	79.83 ± 25.31^{bc}	91.00 ± 23.18^{ab}	95.00 ± 21.93^{ab}
T_3	48.17 ± 20.70^{b}	88.83 ± 25.27^{ab}	91.00 ± 23.18^{ab}	99.60 ± 27.31^{ab}
T_4	61.67 ± 5.51^{a}	90.67 ± 54.86^{a}	104.67 ± 35.00^{a}	171.67 ± 44.79^{a}

Table 3. Effect of Dump site soil on the reproductive growth of *P.vulgaris* after 2 weeks of planting.

Treatments	No. of flowers	Pod fresh weight	Pod dry weight	No. of seeds/Pod
Control (0%)	12	5.01	1.19	8.93
T_1	14	6.88	5.89	10.52
T_2	17	28.72	15.89	11.50
T_3	13	39.93	18.76	11.51
T_4	11	26.51	14.69	10.13

Table 4. Effect of Dump site soil on the number of leaves of *P.vulgaris*.

Treatments	WK 2	WK 4	WK 6	WK 8
Control (0%)	7.00^{c}	13.33^{b}	14.69^{c}	18.33^{b}
T_1	8.33^{bc}	15.67^{ab}	17.33^{bc}	19.33^{b}
T_2	9.33^{ab}	17.67^{ab}	20.33^{ab}	21.00^{a}
T_3	10.00^{a}	20.00^{a}	21.00^{a}	24.00^{a}
T_4	9.33^{ab}	18.33^{a}	20.67^{ab}	20.67^{b}

Table 5. Effect of Dump site soil on the proximate composition of *P.vulgaris* after 8 weeks after planting.

Treatments	Moisture	Ash	Crude fibre	Fat	Protein	Carbohydrate
Control (0%)	9.10 ± 0.14^{ab}	4.25 ± 0.07^{c}	8.60 ± 0.28^{c}	2.65 ± 0.21^{d}	27.65 ± 0.21^{a}	47.75 ± 0.64^{a}
T_1	8.93 ± 0.04^{b}	4.85 ± 0.07^{b}	9.00 ± 0.14^{abc}	3.00 ± 0.28^{cd}	27.75 ± 1.20^{a}	46.48 ± 0.88^{ab}
T_2	8.75 ± 0.04^{b}	5.00 ± 0.28^{ab}	9.15 ± 0.07^{ab}	3.23 ± 0.04^{ab}	27.10 ± 0.14^{a}	45.78 ± 0.53^{b}
T_3	8.80 ± 0.28^{b}	5.13 ± 0.25^{ab}	9.30 ± 0.14^{a}	3.33 ± 0.04^{ab}	28.30 ± 0.42^{a}	45.25 ± 0.28^{b}
T_4	9.75 ± 0.49^{a}	5.45 ± 0.21^{a}	8.75 ± 0.21^{bc}	3.55 ± 0.07^{a}	27.55 ± 1.48^{a}	44.95 ± 0.92^{b}

Table 6. Effect of Dump site soil on the anti-nutritional content of *P.vulgaris* after 8 weeks after planting.

Treatments	Tannin	Phytate	Oxalate	HCN	Trypsin Inhibitor
Control (0%)	0.41 ± 0.00^{b}	0.33 ± 0.00^{c}	0.36 ± 0.01^{d}	9.97 ± 0.01^{d}	48.60 ± 0.00^{b}
T_1	0.44 ± 0.01^{b}	0.26 ± 0.01^{d}	0.38 ± 0.01^{d}	10.10 ± 0.15^{cd}	48.78 ± 0.04^{b}
T_2	0.49 ± 0.04^{b}	0.39 ± 0.01^{c}	0.41 ± 0.01^{c}	10.25 ± 0.01^{bc}	48.81 ± 0.01^{b}
T_3	0.57 ± 0.05^{a}	0.41 ± 0.00^{b}	0.44 ± 0.00^{a}	10.40 ± 0.00^{ab}	49.20 ± 0.28^{a}
T_4	0.63 ± 0.01^{a}	0.53 ± 0.00^{a}	0.47 ± 0.00^{a}	10.63 ± 0.16^{a}	49.51 ± 0.01^{a}

4. Discussion

Results from soil analysis show that of the fifteen (15) parameters measured, dump site soil had greater amount of those compared to top soil; this agree with the report by Ideriah *et al.,* (2010). The high phosphorus (5.99 mg kg^{-1}) and nitrogen (0.29 mg kg^{-1}) content recorded in dump site soil could be attributed to high organic matter found in dump soil (Soheil *et al.,* 2012). The high magnesium (4.00 mg kg^{-1}), sodium (O.14 mg kg^{-1}), and potassium (0.19 mg kg^{-1}) content in the dump site soil can also be attributed to organic matter of the dump site soil (Essien and Nnawuihe, 2013). It was also discovered that the organic matter content of dump site was significantly higher than that of top soil and this is as a result of the living and dead plant and animal activities in the soil (Ideriah *et al.*, 2013). The dump site soil pH (5.99) confirmed that the soil was acidic and this could be as a result of high exchange acidity (EA). Exchange acidity is the concentration of acidic cation (H^+ and A) present in soil solution. This is used as anion balance for cation. High EA can be attributed to organic carbon and organic matter as it shows the fertility status of the soil (Essien and Nnawuihe, 2013).

Findings on the effect of dump site soil on the plant height show that the soil had an increasing effect on the height of *P. vulgaris* plant over the eight (8) week period of growth as the height of the plant increased with increase in the proportion of the dump site soil used in cultivating the crop as against top soil and this supports findings by (Ozdemir, 2005; Theodoratos *et al*. 2000).

The number of flower, pod fresh and dry weight and the number of seeds per pod increased with increase in the dump site soil proportion (DSSP) till in T_5 where there is a sharp decline in all four (4) parameters measured. This result and trend is supported by Soheil *et al*., (2012) who stated that excessive compost manure would have negative effect on physical characteristics; Gautam *et al*., (2012) also had similar report on the growth and yield of Indian mustard.

Like what was observed in the number of flower, pod fresh and dry weights, and the number of seeds per pod, there was an increase in the number of leaves of *P. vulgaris* with increasing dump site soil proportion (DSSP) and highest number of leaves was observed in T_4. However, this was followed by a decrease in the number of leaves and again this result agrees with reports by (Soheil *et al*., 2012; Gautam *et al*., 2012).

Results from the proximate analysis reveal that the moisture content of sample was not significant ($P \geq 0.05$) except for T_4 (100% DSSP) whose moisture was significantly different when compared to others. T_3 with the lowest moisture content will have a prolonged shelf life, as microbial activities are favored by high moisture content (Gernah *et al*., 2010). The ash content of T_1-T_4 (25%-100%) were significantly different when compared with the control as this shows that the ash content increased by the addition of dump site soil. High ash content is of significance in measuring the mineral content of the species as the amount of ash shows the richness of the food in terms of element composition (Hanan *et al*., 2009). Crude fibre content increased significantly with increase in the dump site soil proportion (DSSP). Crude fibre is important for animal feed as it is needed in a reasonable amount in their diet to help in the movement of food through the digestive tract (Elsiddig and Abduhafiz, 1996). Also crude fibre can be a source of energy to the animal body (Salih and El. Hardallou, 1986). The increase in the fat content was observed to be as a result of increase in treatment proportion, however the fat content of the samples studies were low compared 7.1 and 7.2 % reported for *Ipomea batata* and *Larpotea ovalifolis* grown on dump site soil (Ogbemudia *et al*., 2013). There was no significant difference between the protein content of the *P. vulgaris* planted on different dump site soil proportion compared to the control. However, plants in T_3 had highest protein content of 28.30 % which can be attributed to *P. vulgaris* containing a storage protein phaseolin (Ma and Bliss, 1978). This protein value compares favourably with other plants like cassava (*Mlanihot utilisima*), *Piper guineeses*, *Talinum triangulare* and with *Vigna unguiculata* values of 24.88%, 29.78%, 31.00%, and 15.8% respectively (Akindahunsi and Salawu, 2005; Audu and Aremu, 2011). *P. vulgaris* had the highest carbohydrate content of 47.75 % in the control (top soil) and this decreased as the DSSP increase indicating an dump site soil has a reductive effective on the carbohydrate content of the plant.

The result of the anti-nutrition factors present in *Phaseolus vulgaris* showed there were different amounts of tannin, phytate, oxalate, hydrogen-cyanide (HCN), and trypsin inhibitor. The amount of these substances increased with increase in the dump site soil proportion. Anti-nutritional content in food may cause potent human poison. Interestingly, cooking properly before consumption significantly reduces the oxalate and other anti-nutritional factor in foods (Akwaowo *et al*., 2000).

5. Conclusion

The findings from this study confirms the fact that dump site soil exerts effect both positive, negative and mixed (both positive and negative) on the overall growth, nutritional and anti-nutritional content of common bean *P.vulgaris*. Therefore, controlled use of the soil can be of help in improving the productivity of the plant.

References

[1] Akindahunsi, A.A., and Salawu, S.O. (2005). Phytochemical Screening and Nutrient-anti-nutrient composition of selected Tropical Green leafy vegetables. *Afr. J. Biotech*., 4:497-501.

[2] Akwaowo, E.U., Ndon, B.A., and Etuk, E.U. (2000). Minerals and anti-nutritents in fluted pumpkin (*Telfaria occidentalis*). *Food Chemistry,* 70: 235-240.

[3] Arau'jo, A.S.F., Santos, V.B., and Monteiro, R.T.R. (2008). Responses of soil microbial biomass and activity for practices of organic and conventional farming systems in Piaui state. *Brazil European Journal of Soil Biology*, 44: 25-30.

[4] Audu, S.S., and Aremu, M.O. (2011). Effects of processing on chemical composition of red kidney bean flour. *Pakistan Journal of Nutrition,* 10(11): 1069-1075.

[5] Castaldi, P., Garau, G., and Melis, P. (2004). Influence of compost from sea weeds on heavy metal dynamics in the soil-plant system. *Fresen Environmental Bulletin*, 13: 1529-1538.

[6] Debouck, D.G. (1991). Systematics and morphology. In: Van Schoonhoven A, Voysest O. eds. *Common beans; research for crop improvement*. Wallingford, UK: CAB Publishing. pp. 55-118.

[7] Dueñas, M., Fernández, D., Hernández, T., Estrella, I., and Muñoz, R. (2005). Bioactive phenolic compounds of cowpeas (*Vigna sinensis* L). Modifications by fermentation with natural microflora and with *Lactobacillus plantarum* ATCC 14917. *Journal of the Science and Food and Agriculture* 85: 297 – 304.

[8] Elsiddig, A.E., and Abdulhafiz, A.E. (1996). Effect of *Rhizobium* inoculation, organic and chemical fertilizers on proximate compostion, *In-vitro* protein digestibility, tannin and sulphur content of faba beans. *Food Chemistry.* 59(1): 41-45.

[9] Essien, O.E., and Nnawuihe, O.C. (2013). Effect of Service Technology Upgrade on Dump-Trip Time and Efficiency of Solid Waste Collection in Uyo Metropolis Nigeria. *The International Journal of Engineering and Science,* 2(6): 37-47.

[10] Gautam, S., Singh, A., Singh, J., and Shikha. (2012). Effect of Flyash Amended Soil on Growth and Yield of Indian Mustard (*Brassica juncea*). *Advances in Bioresearch,* 3(4): 39 – 45.

[11] Gepts, P., and Debouck, D.G. (1991). Origin, domestication, and evolution of the common bean, *Phaseolus vulgaris*. In: Voysest O, Van Schoonhoven A. eds. *Common beans: research for crop improvement*. Wallingfor, UK: CAB Publishing. pp. 7-53

[12] Gernah, D.I., Akogwu, A.M., and Sengev, A.I. (2010). Quality evaluation of cookies produced from composite blend of wheat flour and African locust bean fruit pulp flour. *Nigerian Journal of Nutritional Science*, 31: 20-24.

[13] Hanan, A.T., Madlen, M.H., and Hanaa, M.S. (2009). Residues of some heavy metals and hormones in freshwater prawn (*Macrobrachium rosenbergii*) and marine shrimps (*Penaeus semisulcatus*) with reference to their nutritive value. *World Journal of Zoology,* 4(3):205-215.

[14] Ideriah, T. J. K., Harry, F. O., Stanley, H. O., and Igbara, J. K. (2010), Heavy Metal Contamination of Soils and Vegetation around Solid Waste Dumps in Port Harcourt, Nigeria. *Journal of Applied Science. Environ. Manage*. 14(1): 101 – 109

[15] Ideriah, T.J.K., Ikpe, F.N., and Nwanjoku, F.N. (2013). Distribution and speciation of heavy metals in crude oil contaminated soils from Niger Delta, Nigeria. *World Enivronment,* 3(1):18-28.

[16] Juhi, M., Rattan, D.S., Vikas, S.J. and Manju, G.A. (2010). Assessment of phenolic components and antioxidative activities of *Phaseolus vulgaris* L. *International Journal of Integrative Biology,* 9(1), 26-30

[17] Liener, I.E. (1994). Implications of anti-nutritional components in soyabean foods. *Critical Reviews in Food Science and Nutrition,* 34: 31 – 67.

[18] Ma, Y., and Bliss, F.A. (1978). Seed proteins of common bean. *Crop Sci.* 17: 431–437.

[19] Nowacki, E. (1980). Heat-stable anti-nutritional factors in leguminous plants. In: Summerfield RJ, Bunting AH (editors). *Advances in Legume Science*., UK: Royal Botanic Gardens, Kew, Richmond, Survey. pp.171 – 177.

[20] Ogbemudia, F.O., Bassey, I.N., and Ette, B.I. (2013). Soil properties, nutritent and anti-nutrient properties of two medicinal vegetables growing in two popular dump sites in Akwa Ibom State, Nigeria. *Merit Journal of Environmental Sciences and Toxicology,* 1(3): 60-65.

[21] Oomah, B. D., Cardador-Martínez, A. and Loarca-Piña, G. (2005). Phenolics and antioxidative activities in common beans (*Phaseolus vulgaris* L). *Journal of the Science and Food Agriculture* 85: 935-942.

[22] Ozdemir, S. (2005). Effects of municipal solid waste (msw) compost on nodulation, plant growth and mineral composition of chickpea in marginal land. *Fresenius Environ. Bull*. 14: 599-604.

[23] Pedra, F., Polo, A., Ribeiro, A., and Domingues, H. (2007). Effects of municipal solid waste compost and sewage sludge on mineralization of soil organic matter. *Soil Biology Biochemstry*, 39: 1375-1382.

[24] Salih, F.A., and El-Hardallou, S.B. (1986). The yirld performance and proximate analysis of twelve cultivars of faba beans grown at five states in the Northern region of Sudan. *FABIS Newsletter.,* 15: 52-55.

[25] Singh, S., and Agrawal, S.B. (2009). Use of ethylene diurea (EDU) in assessing the impact of ozone on growth and productivity of five cultivars of Indian wheat (Triticum aestivum L.). *Environ Monit Assess.* 159:125-41.

[26] Soheil, R.I., Hossien, M.H., Gholamreza, S., and Hassan, E. (2012). Effects of composted municipal waste and its leachate on some soil chemical properties and corn plant responses. 2(6):801-814.

[27] Sposito, G.L., Lund, J., and Chang, A.C. (1982). Trace metal chemistry in arid-zone field soils amended with sewage sludge: fractionation of Ni, Cu, Zn, Cd and Pb in soild phases. *Soil science social American journal,* 46: 260-264.

[28] Theodoratos, P., Moirou, A., Xenidis, A., Paspaiaris, I. (2000). The use of municipal sewage sludge for the stabilization of soil contaminated by mining activities. *J. Hazerd. Mater. B*, 77: 177-191.

[29] Voysest, O.L. and Fernandez, F.C. (1986). Bean Improvement by introduction and selection, CIAT International Center Tropical Agriculture, Colombia. pp.32.