Journal of Agriculture and Sustainability
ISSN 2201-4357
Volume 9, Number 1, 2016, 83-103

Growth Analysis and Fruit Yield of *Capsicum Chinense*, Jackquin as Influenced by Compost Applied as Foliar Spray and Soil Augmentation in Ibadan, Southwestern Nigeria

Dada, O. A. and Ogunsesu, Y. O.

Department of Crop Protection and Environmental Biology,
University of Ibadan, Nigeria

Corresponding author: Dada, O. A., Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria

Abstract: Foliar feeding of plant nutrients promotes maximum nutrient absorption by increasing sugar level in plants thereby stimulating soil activity and plant nutrient uptake. Application of compost as foliar spray is a rare cultural practice among vegetable growers in Nigeria. It is however not clear, if conventional soil augmentation with compost will enhance performance of pepper plant better than foliar spray with compost extract. Therefore, growth, dry matter and fruit yield of pepper *Capsicum chinense,* Jackquin as influenced by either foliar spray or soil augmentation with compost was investigated. Two field trials were conducted during 2014 and 2015 early planting seasons at the Crop Garden of Department of Crop Protection and Environmental Biology Univeristy of Ibadan. Six treatments comprising of two pepper (NHCaC9 and a landrace) varieties and two methods of compost application (Foliar and soil augmentation) and a control (no fertilizer) were laid out in RCBD with three replicates. Compost and compost extract were prepared following standard procedures. Compost was applied at the rate of 8t N ha^{-1} as soil amendement two weeks before transplanting while 0.48 kg/L ≡ of 8 t N ha^{-1} was applied as foliar spray with a hand sprayer fortnightly. Data were collected on growth, dry matter, yield and yield components. Percentage crude protein content was determined using standard procedures. Application of compost extract as foliar spray enhanced growth, development and quality of pepper better than soil augmentation. The indigineous pepper cultivar produced the highest fruit yield (472.00 kg/ha) on plots sprayed with foliar compost extract. Interaction between methods of compost application and the two pepper varieties had no significant effect on net assimilation rate but traditional cultivar sprayed with compost extract had the highest net assimilation rate (0.03g/cm^2/day). Fruits of NHCaC9 cultivar harvested on plots incorporated with compost had the highest (43.45%) crude protein content.

Keywords: Growth analysis, Foliar compost application, Pepper fruit yield.

Introduction

Pepper (*Capsicum chinense,* Jackquin) also called King chili finds importance in human diets as condiments, processed meat flavour, colourant and medicinal purposes (Alabi, 2006). It is highly rich in vitamins especially vitamin C. Pepper is an important fruit vegetable in the tropics and the world second most important vegetable after tomatoes (Olaniyi and Ojetayo, 2010). In Nigeria, the genus is represented by two cultivated species (*Capsicum annum* L. and *Capsicum frutescens* L.), comprising six varieties (Odeigah *et al.*, 1999; Boslandand Votava 1999). Nigeria produces 50% of total production in Africa. FAO (2008) reported that Nigeria produced 695,000 metric tons from total area of 77,000 ha. The bulk production of pepper is found in the drier Savanna zone and derived Savanna areas of the southwestern Nigeria (Anon, 2006).

Abiotic constraints, especially soil nutrient deficiencies add up to biotic constraints that predispose plants to stress. These stresses result in anatomical and physiological disorders that reduce yield (Jackson, 1986). Pepper is a heavy feeder of NPK that requires a liberal application of 450 kg/ha N, 220 kg/ha P and 400 kg/ha K (Berke, *et al.,* 2005) for optimum performance. Regretably, pepper growers in Nigeria face difficulty in supplying this required nutrient as result of perennial problems of availability and affordability of inorganic fertilisers. One of the ways of increasing the soil nutrient status is by applying either organic materials such as poultry manure, animal waste, and use of compost or inorganic fertilizers (Dauda *et al.,* 2008). Organic manure is useful in improving soil physical conditions, steady nutrient supply and increase crop yield. Compost acts as a major contributor to cation exchange capacity as well as buffering agent against undesirable pH fluctuation (Ngeze, 1998). Crops cultivated on compost fertilised field are not only free from harmful chemicals; but are also safer, healthier, tastier and high nutritional quality (Yai and Radav, 2004).

Fertilizers could be applied directly to soil as soil incorporation or applied as foliar spray on plants. According to Akanbi *et al.* (2007), foliar feeding is an effective method for correcting soil deficiencies and overcoming soils inability to transfer nutrients to the plant. It is recognized that supplementary foliar fertilisation during crop growth improved mineral status of plants and increased crop yield and quality (Kolota and Osinska, 2001; Kuepper, 2003). Foliar feeding addresses the immediate needs of a growing crop, as opposed to long-term soil deficiencies. Similarly, plants absorb nutrients 20 times faster when applied as foliar spray than soil-applied nutrients. Besides, foliar spray of fertilizer helps plants compensate for soil deficiencies like low fertility, low soil temperature, low uptake, nutrient fixation etc. Nonetheless, to overcome these challenges of soil augmentation, it would be necessary to use better application method that would improve nutrient uptake and its utilization in fruit or leafy vegetable production. The conventional method of applying compost in vegetable fields was through soil augmentation prior sowing however, with marginal yield increase. It is however not clear whether yield, dry matter accumulation and quality of pepper fruit would improve under compost augmentation through foliar spray method or direct application to soil. Therefore, this study investigated comparative effects of compost applied as foliar spray and soil incorporation on growth, dry matter, fruit yield and protein content of *Capsicum chinense* in Ibadan, southwestern Nigeria.

Materials and methods

Two field trials were conducted during 2014 and 2015 planting seasons at the Crop Garden of the Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria. The site had been previously cropped with *Abelmoschus esculentus* (Okra) and *Zea mays* (Corn). The dominant weeds encountered at the site were *Tithonia diversifolia*, *Panicum maximum*, *Tridax procumbens, Synedralla nodiflora, Commelina benghalensis* and other herbacious weeds.

Compost was prepared following the method described by Oworu and Dada (2009). The soil collected from each plots at the depth of 0-15 cm were bulked together. Pre-cropping nutrient status of the soil and compost were determined as described by Olaleye *et al*. (2007). The results is presented in Table 1.

Seeds of two pepper varieties: NHCaC9 and a landrace used were respectively obtained from National Horticultural Research Institute (NIHORT) and a peasant farmer both in Ibadan. The seeds were raised in nursery for eight weeks before being transplanted to field. The site was manually cleared and debris parked after which 1 m × 1.2 m size beds were made with 1 m furrow path in between the beds. The experiment was laid out in randomized complete block design (RCBD) with three replicates. There were 12 plants per plot; which gave plant density of 10,000 plants/ha. Two plants at the middle of the plot were tagged for data collection. Two weeks before transplanting, 8 tons/ha compost based on N content was applied to each plots alloted soil augmentation treatment. Compost extract was prepared by soaking 240 g compost in a litre of water for 24 hours. The extract was drained out with muslin cloth. Compost extract was applied at the rate of 0.48 kg/l equivalent of 8 t/ha N was applied as foliar spray commencing from two weeks after transplanting with hand sprayer. This was done forthnightly till anthesis.

Data collection

Data were collected on growth parameters such as: number of leaves and branches, plant height (cm), stem diameter (cm), leaf area (cm^2), (West *et al.,* 1920). Data collection covered vegetative, reproductive and physiological maturity phases. At final harvest, the tagged plants were uprooted and oven dried at 70 ^{0}C till constant weight was attained. The shoot and root were weighed separately on sensitive balance to determine the dry matter yield of the crop.

The following growth analyses were evaluated from the dry matter data:

Crop Growth Rate (C) $C = \frac{W_2 - W_1}{T_2 - T_1}$ (g/g/day)

Where: *W1 = Dry weight of initial harvest, W2 = Dry weight of final harvest, T2 = Time at final harvest (Days), T1 = time initial harvest.*

Relative Growth Rate (R) $R = \frac{Log_e W_2 - Log_e W_1}{t_2 - t_1}$ (g/g/day)

Where: Log_e = natural logarithm, t_1= time one (in days), t_2 = time two (in days), W_1= Dry weight of plant at time one (in grams). W_2= Dry weight of plant at time two (in grams).

Net Assimilation Rate (E) $E = \frac{W_2 - W_1}{T_2 - T_1} \times \frac{Log_e LA_2 - Log_e LA_1}{LA_2 - LA_1}$ (g/cm²/day)

Where: Log_e= natural logarithm, t_1= time one (in days), t_2= time two (in days), W_1= Dry weight of plant at time one (in grams). W_2= Dry weight of plant at time two (in grams), LA = Leaf area.

The percentage (%) crude protein of the air-dried materials was determined using the methods AOAC, (1998). All analyses were carried out in duplicate.

Data Analysis

Data collected were analysed with ANOVA of Statistical Analysis System (SAS, 2002). The different means were separated by Least Significant Difference (LSD) at $p \leq 0.05$.

Results

Effects of methods of compost application on growth of two pepper cultivars.

The effect of application of compost either as soil augmentation or foliar application on growth of *Capsicum chinense* Jackquin is presented in Table 2. The results showed that application of compost either as soil incorporation or foliar spray had no significant effect on height of pepper during vegetative growth phase. Whereas, plots sprayed with compost extract had signifantly tallest (26.34 and 38.63 cm) plants at reproductive and physiological maturity growth phases, respectively.

The response of the two varieties with respect to height was not significantly influenced by methods of compost application at vegetative and reproductive growth phases but NHCaC9 had significantly taller (36.27cm) plants at physiological maturity stage.

The interaction between methods of compost application on two varieties of pepper showed that NHCaC9 cultivar had significantly tallest (27.52 and 40.57cm) plants on plots sprayed with compost both at reproductive and maturity phases, respectively.

Similarly, number of leaves produced both at vegetative and reproductive phases were not significantly influenced by soil incorporation or foliar spray with compost extract. However, foliar application of compost extract significantly increased number of leaves produced at maturity phase (Table 2).

Methods of compost application had no significant influence on number of leaves produced by the two pepper varieties. Local variety had higher leaves (27.61) at the vegetative phase while, NHCaC9 had higher (65.61 and 137.89) leaves at reproductive and maturity stages.

The effect of methods of compost application on two varieties of pepper showed that there was no signifcant diffrence in number of leaves produced. However, NHCaC9 produced higher (78.50 and 175.17) leaves in plots sprayed with compost extract at reproductive and maturity stages.

Compost application as foliar spray or soil incorporation had no significant effect on stem diameter however, plants sprayed with compost extract had widest stem (0.79cm). Similarly, NHCaC9 had wider stem diameter (0.73cm) at final harvest. The interaction between methods of compost application on two varieties of pepper showed that local cultivar sprayed with compost extract had highest stem diameter at vegetative (0.46 cm) and reproductive (0.55 cm) stages while, cultivar NHCaC9 had highest stem diameter at final harvest (0.81cm).

Foliar application of compost extract significantly influenced leaf area of pepper. Highest leaf area (387.20 cm^2) was observed in plots sprayed with compost. Although, there was no significant difference in leaf area of the two pepper varieties but, NHCaC9 had higher (311.71cm^2) leaf area. Interaction between the two pepper varieties and methods of application showed that foliar application of compost to NHCaC9 cultivar enhanced leaf area (504.40cm^2) significantly.

Number of branches produced by the two varieties of pepper under different methods of compost application followed similar trend as for other growth parameters. Plots that were sprayed with compost had significantly highest (30.92) number of branches while no significant difference was observed between the two pepper varieties but NHCaC9 produced higher (27.67) number of branches. Also, NHCaC9 cultivar had significantly highest number of brances (37.17) in plots sprayed with compost extract (Table 2).

Effects of methods of compost application on dry matter of two pepper cultivars

Dry matter accumulation by pepper was significantly influenced by methods of compost application. Foliar spray of compost enhanced dry matter accumulation better than soil incorporation. Although, dry matter accumulation by the two pepper cultivars was not significantly different but NHCaC9 had higher shoot (15.07g), root (2.34g) and total (18.08g) dry matter compared to local cultivar. Whereas the interaction between methods of compost application to the two pepper cultivar was not significantly different, NHCaC9 recorded highest shoot (19.65g), root (3.33g) and total (24.25g) dry matter on plots srayed with compost extract (Table 3).

Effects of methods of compost application on yield of two pepper cultivars.

Application methods of compost either as incorporation or foliar spray had significant influence on yield and yield components of pepper. Number of fruits produced was significantly highest (25.67) in plots sprayed with compost extract. Whereas, no significant difference was observed between the two pepper cultivars, local cultivar had higher (16.11) number of fruits. Also, interaction between the two pepper varieties and methods of application of compost showed that local pepper cultivar had significantly higher (33.67) fruit formation on plots sprayed compost extract than the other treatments (Table 4).

Compost application methods on pepper had no significant effect on fresh weight of fruit but plots sprayed with compost extract recorded the highest fresh fruit weight (36.86g). Although, there was no significant difference in the two pepper cultivars although local pepper cultivar had the highest (24.77g) fruit fresh weight (Table 4). The interaction between methods of application of compost and the two cultivars of pepper had no significant effect on fresh fruit weight but local pepper cultivar produced the higher fresh fruit weight (50.24g) on plots sprayed with compost extract. The indigineous pepper cultivar had the higher fruit yield (472.00 kg/ha) on plots sprayed with foliar compost exteact.

Methods of compost application had no significant influence on harvest index of pepper plant but plots sprayed with compost extract had the highest (4.01) harvest index compared to plots incorporated with compost prior to transplanting (Table 4). Also, there was no significant difference in harvest index of the two pepper varieties nevertheless, local cultivar had higher (2.92) harvest index (Table 4). Interaction between the two pepper methods and methods of application of compost had significant effect on the two pepper cultivars. Indigenous cultivar sprayed with compost extract had significantly higher (7.14) harvest index (Table 4).

Growth analysis of pepper varieties as influenced by methods of compost application

Methods of compost application had no significant effect on growth analysis of pepper varieties. Plot incorporated with compost had highest (2.31 g/g/day) crop growth rate (Table 5). There was no significant difference in growth rate of the two pepper cultivars although the local cultivar had higher (1.98 g/g/day) rate of growth (Table 4.4). Interaction between the pepper cultivars and methods of application showed no significant difference in rate of pepper growth but the improved cultivar (NHCaC9**)** had higher (2.53 g/g/day) growth rate on plots incorporated with compost (Table 5).

Similarly, compost application methods on pepper cultivars had no significant influence on relative growth rate but plot sprayed with compost extract had 0.06 g/g/day while the control had lowest (0.02 g/g/day) relative growth rate (Table 4.4). The interaction between the two factors indicated that there was no significant difference with respect to relative growth rate. However, both cultivars had higher (0.07g/g/day) relative growth rate in plots sprayed with compost extract. (Table 5).

Methods of application of compost on pepper had significant influence on the growth analysis but plots incorporated with soil compost had the highest (0.03 g/cm^2/day) net assimilation rate. Also, there was no significant difference between the two pepper cultivars with regards to methods of application of compost. However, local variety had the highest (0.02g/cm^2/day) net assimilation rate (Table 5). Interaction between methods of application of compost and the two pepper cultivars had no significant effect on net assimilation rate but local variety sprayed with compost extract had the highest net assimilation rate (0.03g/cm^2/day).

Effects of methods of compost application on percentage crude protein of two pepper varieties.

The influence of methods of compost application on protein content of pepper is shown in (Table 6). The results showed that fruit of NHCaC9 cultivar harvested on plots incorporated with compost had the highest (43.45%) crude protein content. Least protein content (26.25%) was observed in fruits of indigeneous pepper cultivars grown on control plots.

Discussion and conclusion

The study revealed that foliar spray of compost extract promoted growth and development of pepper in terms of height, number of leaves and branches produced, stem diameter and canopy cover better than soil augmentation or the control. This could probably be due to better assimilation of the available nutrients in compost extract directly into the xylem tissue of the leaf surface through the stomata. Since water potential in the compost extract is expected to be lower thereby promoting better movement of solute into the xylem which may likely encourage growth and development as observed by Maier-Maercket (1979).

Growth response of the two pepper cultivars showed that improved cultivar responded better to compost application than local cultivar. It had been observed that different species within a variety exhibit different response to compost application. Adetiloye and Salau (2002) had reported that variation in the response of different crops of similar species might be due to their genetic makeup. The superior performance of improved cultivar over traditional cultivar may be due to high degree of agronomical variation premised on selection from breeding outcome. Foliar spray of compost extract on improved variety enhanced growth and development better than the indigenous cultivar. This is likely to be due to breeding output whereby growth attributes such as plant height, number of leaves, stem diameter e.t.c. that contribute significantly to yield and yield components had been improved upon better than the traditional cultivar (Weir, 1990; Lahbib and Mohamed, 2013; Quartey *et al.*, 2014).

Foliar spray of compost extract enhanced dry matter accumulation and partitioning into shoot and root of improved cultivar better than observed in indigenous cultivar treated with either methods of compost application. This could be due to the fact that improved cultivar had better shoot development than landrace. Better shoot formation is a good source of photoassimilate that determine the extent to which dry matter is partitioned into sink. This observation is similar to that of Sharma and Sardana (2012). The superior response of improved cultivar over the traditional one with respect to dry matter yield on plots treated with foliar compost spray could be due to ease of assimilates translocation towards the desirable sinks as compared with the control. Similar results had been reported by Mondal (2007) in mungbean.

With respect to fruit yield, plots sprayed with compost extract had the highest fruit yield. This could be due to stimulatory effect of the compost extract which possibly promoted physiological performance of the plant. Besides, foliar compost application perhaps facilitated rapid and efficient nutrient use independence of soil conditions. Similar results by Matilo *et al.* (2006) showed that wheat grain and straw yield were significantly increased by the integral application of urea through broadcast and foliar spray over soil application alone. It was also recognised that supplementary foliar fertilisation during crop growth improved the mineral status of plants and increase the crop yield (Mosluh *et al.*, 1978 and Kolota and Osinka, 2001 and Pant *et al.*, 2009).

Varietal response of *Capsicum* spp. to methods of compost application with respect to fruit yield showed that the indigenous cultivar had higher fruit yield than the improved cultivar which is contrary to the growth performance. The observed yield trend suggests that the improved cultivar favoured biolgical yield at the expense of economic yield. This could be due to the fact that the local landrace adaptated to the local growing environment better than the improved variety. Local landraces have been reported to adapt favourably to local growing conditions while the improved or exotic varieties easily succumb to the vagaries of the weather and other abiotic and biotic determinants of yield (Quartey *et al.*, 2014).

Indigenous cultivar was observed to have efficently utilised foliar compost spray for fruit production than the improved cultivar probably which may imply that this cultivar absorbed and appropriately utilised the sprayed compost for synthesis of photoassimiliate which was partitioned into sink for fruit formation better that the improved cultivar. This agrees with the observation of Röemheld and El-fouly (1999) that the efficiency of foliar feeding is higher than that of soil fertilization. Besides, genotypically, landrace appeared efficient in utilizing the applied compost better than NHCaC9. Our observation is in agreement with Sezen *et al.* (2011) who reported that fruit yield in pepper is usually influenced by both genotypic and environmental conditions.

The higher rate of growth observed in plots incorporated with compost suggests that soil incorporation favoured better dry matter accumulation than foliar application. Application of compost to poor soil had been reported to improve soil physical and chemical properties thereby enhancing crop nutrient uptake. This is in line with the observation of Abd Alla (1998) and Abd El-Hamid *et al* (2004). Similarly, better crop growth observed in local cultivar could probably be due to better dry matter production which is occasioned by the efficient nutrient utilisation by the cultivar. Report of Morris *et al.* (1999) is in consonace with our observation.

The highest CGR and NAR observed in the local cultivar grown on plots sprayed with compost implies that the cultivar was efficient in producing new dry matter with its leaf area better than NHCaC9. Karakurt *et al.* (2009) concluded that foliar application of humic acid led to significantly higher mean fruit weight and early total yield than the control.

The higher crude protein content observed in foliar and soil fertilised plots over the control suggests that compost released considerable amount of nutrient especially Nitrogen (N) for plant use than the control. This is in agreement with the observation of Akanbi 2002. The considerable variability in the efficacy of compost applied either as foliar or soil augmentation for promoting crop growth had been suffienctly documented (Kolota and Osinska, 2001, Kuepper, 2003, Karakurt *et al.* 2009, Dada, *et al.,* 2014). However, beneficial effects of compost application are complex and depend on many factors, including plant species, compost quality, extraction method, and growing conditions.

Conclusion

Application of compost extract as foliar spray enhanced growth, development and quality of pepper. The use of foliar spray of compost was beneficial to plant and likely to minimize compost transportation cost coupled with its environment friendly attribute. It is therefore recommended that foliar spray of compost should be encouraged among pepper growers. There is also the need for plant breeders to evaluate the available local pepper genotypes in order to identify superior genotypes with desireable growth and yield traits under prevailing field condtions. This should provide breeders with useful information necessary for breeding new varieties adaptable to Ngeria agroecosystem.

Acknowledgement

The authors are sincerely grateful to Dr. Tairu Folasade .M of the National Horticultural Research Institute (NIHORT), Ibadan for supplying the improved seed cultivar used for the trial.

References

[1] A.O.A.C., 1998. Official Method of Analysis, 15th Ed., Association of Official Analytical Chemists, Inc., USA.

[2] Awad, E.M., 2002. Effect of compost and some bio-fertilizers on growth, yield and quality of potato crops *(Solanum tuberosum L.). J. Agric. Mansoura Univ*., 27(8): 5525-5537.

[3] Abd El-Hamid, M., Hoviuchi, , T and Oba, S. 2004. Composting of rice straw with oil seed rape cakeand poultry manure iteffects on faba bean (*Vicia faba* L.) growth and soil properties.. *Bioresource Technology*. 183 – 189.

[4] Abd-Alla, A M 1998. The growth of pea, green pods yield and their quality as affected by organic, N and K fertilizers. *Egypt J. Agric. Sci*.: (13) 292 – 304.

[5] Adetiloye, P.O. and Salau, A.W. 2002. Response of soybean to inoculation with Rhizobium in South Western Nigeria. *Tropical Oilseeds Journal* 7: l-l

[6] Akanbi, W.B., 2002. Growth, Nutrient uptake and yield of maize and okra as influenced by compost and nitrogen fertilizer under different cropping systems. Ph. D. Thesis, University of Ibadan, pp: 233.

[7] Akanbi, W.B., Adebayo T. A., Togun, O. A., Adeyeye, A. S. and Olaniran, O. A. 2007. The use of compost extract as foliar spray nutrient source and botanical insecticide in *Telfairia occidentalis*. *World Journal of Agricultural Sciences* 3 (5): 642-652.

[8] Alabi, D. A. (2006) Effects of fertilizer phosphorus and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annuum* L). *African J. Biotechnology* (8): 671-677.

[9] Anons, 2006. Nasarawa State Agricultural Development Programme, Annual Crop Area and yield Survey (CAYS), Lafia, Nasarawa State.

[11] Berke, T. G. Black, L. L. Morris, R. A. Talekar N. S. and Wang, J. F. 2003. Asian Vegetable Research and Development Centre (AVRDC). 99-497R.

[12] Bosland, P.W. and Votava, E.J., 1999. Peppers: vegetable and spice capsicums. CABI Publishing, Wallingford, United Kingdom. 204 pp.

[13] Dada, O. A., Togun, A. O., Adediran, J. A and Nwilene, F. E. 2014. Growth, nutrient uptake efficiency and yield of upland rice as influenced by two compost types in tropical rainforest-derived savannah transition zone. *Agricultural Sciences*, 5. 383-393.

[14] Dauda, S.N., F.A. Ajayi and E. Ndor, (2008). Growth and yield of water melon (*Citrullus lanatus*) as affected by poultry manure application. *J. Agri. Soc. Sci.*, 4: 121–4.

[15] FAO 2008. Food and Agriculture organization of the United Nations., 82pp

[16] Jackson, R. D. 1986. Remote sensing of biotic and abiotic plant stress. *Ann. Rev. Phytopathol.* 24: 265-287.

[17] Karakurt, Y., Unlu, H., Unlu, H and Padem, H. 2009. The influence of foliar and soil fertilization of humic acid on yield and quality of pepper. *Acta Agriculture Scandinavia, Section B – Plant Soil Science.* 59: 233-237.

[18] Kolota, E. and M. Osinska 2001. Efficiency of foliar nutrition of field vegetables grown at different nitrogen rates. *Acta Hort*., 563: 87-91.

[19] Kuepper G. 2003. Foliar Fertilization Current Topic, ATTRA – National sustainable Agriculture Information service, *NCAT Agriculture specialist* 5p.

[20] Lahbib, K. F and Mohamed, E.G 2013. Selection of pepper parent from collection of *Capsicum annum* landraces based on genetic diversity. *Journal of Plant Breed. Crop Sci.* 5(5) 68-72.

[21] Maier-Maercket U. 1979. Peristomatal transpiration and stomatal movement: a controversial view. III. Visible effects on peristomata transpiration on the epidermis. *Zeitschrifur Pflanzenphysiologie*; 91:225-238

[22] Matilo A., Hassan Z. U., Shah A. N. and Khan H. 2006. Growth, yield and nutrient uptake of wheat (*Triticum eastivum* L.) in relation to foliar and soil application of urea. *Int. J. Agri. Biol.*, 8 (4):477-481

[23] Mondal, M. M. A. 2007. A study of source- sinks relationship in mungbean. Ph.D. Thesis Dept. of Crop Bot. Bangladesh Agri. Uni. Mymensingh.

[24] Morris, M. L., R. Tripp, and A. A. Dankyi. 1999. "Adoption and Impacts of Improved Maize Production Technology: A Case Study of the Ghana Grains Development Project," Economics Program Paper 99-01.

[25] Mosluh K. I., Jagdish S. and Rashid A. K. 1978. Efficiency of urea spray for wheat crop under irrigated conditions in Iraq. *Plant and Soil*, 49: 175-178.

[26] Ngeze PB, (1998). Artificial fertilizers and how to use them. Stantex Publishers, Nairobi, Kenya. 55pp.

[27] Odeigah, P.G. C, Oboh, B and Aghalokpe, I. O. 1999. The characterization of Nigerian varieties of pepper, *Capsicum annuum* and *Capsicum frutescens* by SDS- polyacrylamide gel electrophoresis of seed proteins. *Genetic Resources and Crop Evolution,* 46. 2: 127.131

[28] Olaleye, A. O., Ndubuaku, U. M. and Dada, O. A. 2008.Comparative study of the performance of jute plant (*Corchorus olitorius* L.) on home garden soil, farmland and cocoa plantation soils as influenced by varying levels of N- fertilizer. *Journal of Tropical Agriculture, Food, Environment and Extension.* 7 (1) 78 - 84.

[29] Olaniyi, J. O and Ojetayo, A. E. (2010). The effect of organomineral and inorganic fertilizers on the growth, fruit yield and quality of pepper *(Capsicum frutescence)*. *J. Animal & Plant Sciences,* 8 (3): 1070- 1076.

[30] Oworu, O.O. and . Dada, O. A. 2009. Influence of compost on growth, nutrient uptake and dry matter accumulation of grain amaranths (*Amaranthus hypochondriacus*. L.) on Oxic Paleulstalf. *Nigerian Journal of Science 43: 7-18.*

[31] Pant A, Radovich TJK, Hue NV, Talcott ST, Krenek K.A. 2009. Vermicompost extracts influence growth, mineral nutrients, phytonutrients and antioxidant activity in Pak choi (*Brassica rapa* cv. Bonsai, *Chinensis* group) grown under vermicompost and chemical fertilizer. *J. Sci Food Agric.* 89:2383-2392.

[32] Quartey, E. K., Nunekpku, W., Owusu-Ansah., Appiah, A. S., Ofori, K. S. E and Amoatey, H. M. 2014. Agronomic evaluation of eight genotypes of hot pepper (*Capsicum* spp.) in a coastal savanna zone of Ghana *Journal of Biology, Agriculture and Healthcare*. 4:24. 16-28.

[33] Röemheld V. and El-Fouly M. M. 1999. Foliar nutrient application: Challenge and limits in crop production. Proc. 2nd International Workshop on " Foliar Fertilization" April 4-10 Bangkok, Thailand: 1-32.

[34] Sezen, S.M., Yazar, A., Eker, S and Kapur B. 2011. Yield and quality response of drip-irrigated pepper under mediterranean climatic contitions to various water regimes. *Afr. Jour. Of Biotech.* 10 98): 1329-1339.

[35] Sharma, P. and Sardana V. 2012. Effect of growth regulating substances on the chlorophyll, nitrate reductase, leg haemoglobin content and yield in groundnut (*Arachis hypogea)*. *The Bioscan* 7(1):13-17.

[36] Statistical Analysis System (SAS) Institute. 2002. SAS/STAT user's guide. Version 8. 6th ed. SAS Inst. Cary. North Carolina, pp. 112.

[37] Weir B. S. 1990. Genetic data analysis: methods for discrete population genetic data. Sinauer Associates, Inc. publishers. Sunderland, Massachusetts. 377.

[38] West C, Briggs G. E, Kidd F**.** 1920. Methods and significant relations in the quantitative analysis of plant growth. *New Phytologist* 19: 200-7.

[39] Yai, N and Yadav, D. S. 2004. Advances invegetable production. Researchco book centre, Karol Bagh, New Delhi. 995pp.

Table 1: Pre-cropping physical and chemical analyses of soil and compost

Properties	Soil (0-15cm depth)	Compost*
Soil particle analysis (gkg^{-1})		
Clay	160.0	Na
Silt	94.0	Na
Sand	746.0	Na
Textural class	Sandy loam	Na
pH (H_2O)	6.9	6.6
Organic carbon (gkg^{-1})	23.6	Nd
Organic matter (gkg^{-1})		63.8
Total Nitrogen (gkg^{-1})	2.2	6.6
Available P ($mgkg^{-1}$)	69.4	0.002
Exchange cation ($cmolkg^{-1}$)		
K	0.01	0.7
Na	1.1	335.0
Ca	4.6	0.0023
Mg	0.4	0.4
Extractable micronutrients ($mgkg^{-1}$)		
Cu	3.2	3.9
Mn	221.0	126.5
Fe	106.8	2365.0
Zn	1.2	7.1

*na= Not applicable, nd= Not determined; *Dry weight basis*

Table 2: Effect of soil augmentation and foliar application of compost extract on growth of two *Capsicum chinenses* cultivars

Application methods		**Plant height (cm)/ Plant**			**Number of Leaves/ Plant**			**Stem diameter (cm)/ Plant**			**Leaf area (cm²)/ plant**			**Total number of branches/ plamt**
		Veg	**Rep**	**Mat**	**Veg**	**Rep**	**Mat**	**Veg**	**Rep**	**Mat**	**Veg**	**Rep**	**Mat**	
Foliar		15.71	26.34	38.63	29.00	79.42	159.33	0.44	0.54	0.79	42.94	158.81	387.2	30.92
Incorporation		13.33	19.01	28.04	21.00	50.92	104.00	0.36	0.46	0.65	26.64	76.77	162.8	21.17
Control		13.87	22.02	33.60	29.58	61.58	117.75	0.35	0.46	0.69	19.52	90.03	210.9	19.92
LSD $_{0.05}$		3.25	5.31	6.10	11.77	32.33	53.34	0.10	0.11	0.18	19.04	77.69	210.84	9.99
Varieties														
Landrace		14.40	21.23	30.58b	27.61	62.33	116.17	0.39	0.47	0.69	26.54	90.98	195.52	20.33
NHCaC9		14.21	23.68	36.27	25.44	65.61	137.89	0.38	0.50	0.73	32.87	126.10	311.71	27.67
LSD $_{0.05}$		2.65	4.34	4.98	9.61	26.4	43.55	0.08	0.09	0.15	15.54	63.43	172.15	8.16
Interaction														
Landrace	**Foliar**	16.00	25.17	36.70	31.66	80.33	143.50	0.46	0.55	0.76	38.37	134.67	270.0	24.67
	Incorporation	13.78	18.17	25.83	21.17	48.83	103.83	0.33	0.44	0.65	14.82	57.84	155.9	18.17
	Control	13.42	20.35	29.20	30.00	57.83	101.17	0.37	0.42	0.64	26.42	80.44	160.7	18.17
NHCaC9	**Foliar**	15.42	27.52	40.57	26.33	78.50	175.17	0.42	0.52	0.81	47.50	182.99	504.4	37.17
	Incorporation	12.88	19.85	30.25	20.83	53.00	104.17	0.38	0.49	0.64	24.23	95.70	169.8	24.17
	Control	14.32	23.68	38.00	29.17	65.33	134.33	0.32	0.50	0.73	26.86	99.62	261.0	21.67
	LSD $_{0.05}$	4.60	7.51	8.63	16.64	45.73	75.43	0.13	0.15	0.26	26.92	109.87	298.17	14.13

Veg= Vegetative, Rep= Reproductive,Mat = Physiological Maturity, LSD = Least Significant Difference at P = 0.05

Table 3: Effect of soil augmentation and foliar application of compost extract on dry weight of two *Capsicum chinenses* cultivars

Application methods		Dry weights (g)/plant								
		Shoot			Root			Total		
		Veg	Rep	Mat	Veg	Rep	Mat	Veg	Rep	Mat
Foliar		3.72	4.56	13.67	0.84	0.96	2.93	4.55	5.68	17.54
Incorporation		1.48	3.30	12.08	0.30	0.75	2.10	1.78	4.42	14.42
Control		1.75	2.86	12.39	0.38	0.71	1.99	2.13	3.67	14.65
LSD $_{0.05}$		1.75	3.82	11.56	0.47	0.92	2.03	2.20	4.88	13.96
Varieties										
Landrace		2.36	2.83	10.36	0.61	0.73	2.30	2.97	3.80	13.01
NHCaC9		2.27	4.31	15.07	0.41	0.89	2.34	2.68	5.38	18.08
LSD $_{(0.05)}$		1.43	3.12	9.43	0.38	0.75	1.66	1.79	3.99	2.23
Interaction										
	Foliar	3.49	3.77	7.70	0.89	1.00	2.52	4.38	4.99	10.83
Landrace	Incorporation	1.93	3.37	13.35	0.41	0.80	2.83	2.33	4.57	16.44
	Control	1.67	1.36	10.03	0.52	0.40	1.56	2.19	1.83	11.76
	Foliar	3.94	5.34	19.65	0.79	0.95	3.33	4.73	6.37	24.25
NHCaC9	Incorporation	1.03	3.23	10.81	0.20	0.69	1.37	1.23	4.26	12.49
	Control	1.84	4.36	14.75	0.24	1.03	2.42	2.08	5.50	17.54
	LSD $_{(0.05)}$	2.48	5.40	16.34	0.66	1.31	2.03	3.10	6.90	19.74

Veg= Vegetative, Rep= Reproductive, Mat = Physiological Maturity, LSD = Least Significant Difference at P =0.05

Table 4: Effect of soil augmentation and foliar application of compost extract on yield of two *Capsicum chinense* cultivars

Application methods		Number of fruits/plant	Fresh weight of fruits (g)/plant	Fresh weight of fruits (kg/ha)	Harvest index
Foliar		25.67	36.86	400.60	4.01
Incorporation		8.83	12.31	93.80	0.68
Control		4.50	6.77	77.30	0.83
LSD $_{0.05}$		18.98	30.59	374.85	3.56
Varieties					
Landrace		16.11	24.77	222.90	2.92
NHCaC9		9.89	12.52	158.20	0.76
LSD $_{0.05}$		15.50	24.98	306.04	2.90
Interaction					
	Foliar	33.67	50.24	472.00	7.14
Landrace	Incorporation	10.00	15.78	126.10	0.41
	Control	4.67	8.30	70.70	1.20
	Foliar	17.67	23.48	329.1	0.87
NHCaC9	Incorporation	7.67	8.83	61.50	0.95
	Control	4.33	5.24	83.90	0.45
	LSD $_{0.05}$	28.15	46.79	501.82	5.03

LSD = Least Significant Difference at P = 0.05

Table 5: Effect of soil augmentation and foliar application of compost extract on growth analysis of two *Capsicum chinense* cultivars

Methods of application		CGR (g/g/day)	RGR (g/g/day)	NAR (g/cm³/day)
Foliar		2.25	0.06	0.01
Incorporation		2.31	0.05	0.03
Control		1.25	0.02	0.02
LSD $_{0.05}$		2.40	0.18	0.03
Varieties				
Landrace		1.98	0.07	0.02
NHCaC9		1.90	0.01	0.01
LSD $_{0.05}$		1.96	0.15	0.02
Interaction				
	Foliar	2.14	0.07	0.01
Landrace	Incorporation	2.09	0.05	0.02
	Control	1.70	0.10	0.01
	Foliar	2.37	0.07	0.03
NHCaC9	Incorporation	2.53	0.01	0.02
	Control	0.80	-0.04	0.00
LSD $_{0.05}$		3.40	0.25	0.04

CGR= Crop growth rate, RGR= Relative growth rate, NAR= Net assimilation rate

Table 6. Effect of methods of compost application on percentage crude protein of two pepper cultivars.

Varieties	Methods of Application	Crude Protein (%)
Landrace	Foliar	42.01
	Incorporation	40.55
	Control	26.25
NHCaC9	Foliar	40.45
	Incorporation	43.45
	Control	28.06