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Response of Maize (Zea mays L.) to Integrated Fertilizer Application in Wolaita, South Ethiopia

Fanuel Laekemariam* and Gifole Gidago
Faculty of Agriculture, Department of Plant Sciences, Wolaita Sodo University, P.O box 138, Ethiopia
* E-mail of the corresponding author: laeke2005@yahoo.com

Abstract
An on farm participatory experiment was conducted during rainy seasons of 2009 and 2010 at two locations to introduce the culture of integrated fertilizer management on maize. No fertilizer, blanket dose of inorganic fertilizer (100kg Urea/ha and 100kg DAP/ha), 5ton compost ha^{-1} alone, (5ton compost ha^{-1} + 25kg urea ha^{-1}+ 100 DAP/ha), (5ton compost ha^{-1} + 50kg urea ha^{-1} + 100 DAP/ha), (5 ton compost ha^{-1} + 75kg urea ha^{-1}+ 100 DAP/ha) were evaluated. The experiment was laid out in randomized complete block design with four replications. Soil analysis before sowing indicated that the major nutrients (N, P) were found at low levels, where as the compost analysis indicated as it contained considerable amounts of nutrients. The result indicated that integrated fertilizer application revealed a significant influence ($P<0.001$) on growth, yield components and grain yield of maize. During 2009, the maximum grain yield (6.95 and 6.53 ton ha^{-1}) at Dendo Ofa and Chifisa were obtained from compost with 75 and 50 kg ha^{-1} urea, respectively; which 54.39% higher over the control (3.17 ton ha^{-1}) at Dendo Ofa; and 52.83% more than the control (3.08 ton ha^{-1}) at Chifisa. During 2010, the maximum grain yield (6.05 ton ha^{-1}) which was 50.74% more than sole compost (2.98 ton ha^{-1}) was recorded at Dendo Ofa from compost with 75 kg ha^{-1} urea; whereas, in Chifisa inorganic fertilizer gave maximum grain yield (6.79 ton ha^{-1}) which was 49.04% higher than the sole compost (3.46 ton ha^{-1}). However, statistically similar performances between integrated and inorganic fertilizer applications have been recorded. In the mean while, sole compost and unfertilized plots showed least performance on growth, yield component and grain yield of maize. In general, combined use of compost with inorganic fertilizer at (5 ton/ha + 50kg urea/ha + 100kg DAP/ha) has been suggested than using inorganic fertilizer alone to obtain better growth and yield of maize; and improving physico-chemical properties of the soil on sustainable basis.
Keywords: Compost, Inorganic fertilizer, Integrated Nutrient Management and Maize

1. Introduction

Wolaita is one of the zones in the Southern Ethiopia having high population density, which is 385 persons km-2 (SNNPRS, 2007). Maize is major grain crop in the zone which occupies 42% of the land covered by grain crops (SNNPRS, 2007). However, it is cultivated using traditional practice and maize is low in productivity which is 16 qt/ha (SNNPRS, 2007) while the national yield average is 21qt/ha.

Although different factors are contributing to low productivity, soil fertility is a major concern of crop production in the area. Nitrogen and phosphorous are highly limiting nutrients to support good crop growth and development (Wondewosen,2009) due to the practice of multiple and continues cropping systems using low fertilizer (Tenaw et al., 2006). Despite the cultivation preferences by the farmers in the area, currently chemical fertilizers are beyond the reach of farmers due to high price. The contrary, the alternative organic fertilizers cannot meet crop nutrient demand over large area because of limited availability, low nutrient composition and high labour requirement (Tolera et al., 2005). On the other hand, post harvest use of crop residue for soil management is low due to other uses such as for construction, feeding, fencing, fuel wood and as a source of income (Tenaw et al., 2006). Hence, practices that would address the problem of nutrient deficiency are needed.

Accordingly, the higher the price of chemical fertilizers and the higher organic residue demand in the field, could call up the combined use of compost with inorganic fertilizer approach. As reported by Razwan et al., 2007; Wakene et al., 2001a), the integration of organic fertilizer with inorganic fertilizer increases the potential of the applied fertilizer there by increases crop productivity. So far, in spite of the advice given for farmers' in order to prepare and use compost for their crops, information on the impact of sole compost and/or integrated use of compost with inorganic fertilizer on soil properties and performance of maize productivity is lacking. Therefore, this study was conducted to evaluate soil property, growth, productivity and economic performance of maize in response to integrated fertilizer application.

2. Materials and Methods

2.1. Description of the Study Area

This experiment was conducted at Wolaita Zone, on two woreda's such as Damot Woyide (Chifissa Kebele) and Duguna Fango (Dendo Ofa Kebele), Southern Ethiopia in the main rainy season of 2009 and 2010. Dendo Ofa is found in the altitude 1591m.a.s.l, latitude 07002'14.9" N and 038000'44.5"E. The research sites are found in the altitude ranging between 1300-2200 m.a.s.l, with the minimum and maximum average annual temperature is 160C and 260C, respectively; and the average annual rainfall of 950 mm.

2.2. Treatments and Experimental Design

The experiment was composed of six treatments such as no fertilizer, blanket dose fertilizer i.e. (100kg Urea/ha and 100kg DAP/ha), 5ton compost ha-1 alone, (5 ton compost ha-1 + 25kg urea ha-1+ 100 DAP/ha), (5 ton compost ha-1 + 50kg urea ha-1 + 100 DAP/ha), (5 ton compost ha-1 + 75kg urea ha-1+ 100 DAP/ha). The experiment was laid out in randomized complete block design at four replications. Size of each plot was 11.25 m2 (3 m x 3.75 m).

2.3. Soil Sampling

Thirty five soil samples were randomly collected from surface layer of the experimental field (i.e. 0-30 cm soil depth) to form composite before fertilizer application and analyzed for the soil texture, pH, available P, total N, and OC (Organic Carbon). Besides, compost sample was taken and analyzed for available P and total N. At harvesting, soil samples were also taken from each plot to determine the pH, total N, OC, and available P.

2.4. Laboratory Analyses

The soil samples were air-dried and ground to pass 2 and 0.5 mm sieves (for total N). All samples were analyzed following standard laboratory procedures as outlined by Sahlemedhin and Taye (2000). Organic carbon and total N contents of the soil were determined following the wet combustion method of Walkley and Black, and wet digestion procedure of Kjeldahl method, respectively. The available P content of the soil was determined following Olsen method. Soil texture was analyzed by Bouyoucos hydrometer method. The pH (1:2.5 solid: liquid ratio) of the soils was measured in water using pH meter with glass-calomel combination electrode.

2.5. Crop Management

The experimental land was well prepared. Initially, two seeds per hill were planted and latter thinned to one plant per hill. The spacing was 0.75m and 0.30m between rows and plants, respectively. A total of five rows were kept on each plot. Each plot and block was separated by 1 m and 1.5m, respectively. A plot for inorganic treatment received a blanket dose of 46 kg N/ha (in the form of urea) and 18/46 kg N/P2O5 in the form of DAP. DAP was applied at sowing time while urea was applied by split application (half at planting and the remaining half was given at knee height stage 30 to 40 days after planting). Compost was taken from farmers who received trainings on compost preparation. For plots receiving compost in any form, it was applied at sowing. The compost was applied on planting rows. Improved maize variety Pioneer (PhB 3253) was used for the experiment. Important agronomic practices like hoeing and weeding were uniformly applied to all experimental plots as often as required.

2.6. Plant Data Collection and Analysis

Central row plants were used for data collection. Growth indicating parameters such as plant height, number of leaf per plant, leaf area index, total biomass, stalk weight, ear weight per plant and cob weight per plant); yield components such as (cob length, number of rows per cob, number of seeds per row, number of seeds per cob and total seed number per cob) and grain yield were collected. The plant height (cm) was measured from the base of the plant to upper the top most leaves of the plant. The data was taken from five randomly selected plants at few days after tasseling and the number of leaves per plant was taken from a visual count of the green leaves. The data was taken from five randomly plants and the average value was computed. Leaf area index (LAI) was calculated by leaf area of the plant to ground area covered by the plant. The leaf area per plant was calculated as the product of leaf length and widest middle portion of the leaf and multiplied by correction factor 0.75 (Rajeshwari et al., 2007). Eight plants from the central rows were randomly taken in order to measure the total biomass and stalk weight. The cob length (cm) and number of rows per cob was computed from eight cobs. For the number of seeds per row, eight cobs and from each eight randomly selected rows/cob was recorded. Number of seeds/cob was computed from the average seeds per row multiplied by the average number of rows per cob. Finally, after shelling the cobs, the grain yield from eight plants were recorded and grain yield per hectare was calculated. The grain yield was adjusted at 12.5% grain moisture content.

All the parameters were statistically analyzed using the General Linear Model of Statistical Analysis System software (SAS soft ware). Effects were considered significant if P values were < 0.05. Significant differences among treatment means were tested using LSD (Least Significant Difference) test at 5 % level of significance.

3. Results and Discussions

3.1. Soil Physico-chemical Properties before Sowing and After Harvest

The texture of soil at Chifisa site was sandy clay loam while it was sandy loam at Dendo Ofa. Soil pH of Dendo Ofa site was neutral (pH=6.9) while that of Chifisa was moderately acidic (pH=6). According to Havlin et al. (1999), the pH within two sites was within the range satisfactory for most crops and suitable for deriving maximum benefit from applied phosphorous. Besides, as it was indicated by the same authors, the pH ranges of the soils were sufficient to minimize toxicity while maintaining adequate availability of micro-nutrients. The electrical conductivity (EC) of both study sites was nil which indicates that the soil has no salinity problem (Herrera, 2005). The available phosphorous (P) contents were 3.1 mg kg-1 and 2.2 mg kg-1, at Dendo Ofa and Chifisa, respectively. The available P contents at both experimental sites were low according to Pushparajah (1997). The low P content might be attributed to the uptake or utilization by crops due to continuous cropping with low or no application of P containing fertilizers. The low P content might also be attributed to the lower contents of organic matter (Table 1). The result in this experiment was in agreement with Sahlemedhin (1999) who reported that phosphorous (P) is tied to humus content of the soil and its value decreases with the decrease in organic matter (OC) content. The organic carbon (OC) content was 1.4% and 1.52% for Dendo Ofa and Chifisa, respectively. The OC content of both sites were classified as very low (Landon, 1991). In the mean while, the total N contents were 0.13% and 0.15% for Dendo Ofa and Chifisa, respectively, and based on Landon (1991), the N content at both sites were low. The very low OC and low N content in the study area indicate low fertility status of the soil. This could be due to continuous cultivation, lack of incorporation of organic materials, and relatively higher temperature during experimental time. This finding was in agreement with Wakene et al. (2001b).

Soil analysis for samples taken at harvesting, however, indicated that application of compost alone; and its integration with inorganic fertilizer was not significantly affected selected chemical properties of soils (Table 2). The reason for this result might be the treatments were spot applied (i.e. on planting rows) to feed the crops, not to feed the soil and sampling of the soil did not target spot application points. Another reason might be the gradual release of nutrients (Agromisa, 2005). This result was in agreement with Wakene et al. (2001a), who reported non-significant result due to application of integrated fertilizers in maize trial.

3.2. Chemical Composition of Compost

Compost analysis indicated that it contained 0.6% total nitrogen and 10.3 mg kg-1 available phosphorous. The implication is that application of compost has supplied the soil with 30kg/ha total N and 0.052kg/ha available P during 2009. Besides, applied compost provided the soil with 13.5 kg/ha total N and 0.129kg/ha of available P, during 2010 (Table 3). During 2009, the applied compost supplied 47% and 0.26% of the recommended N rate of maize (64kg N/ha) and P (20kg P/ha), respectively. During 2010, the applied compost supplied 21% and 0.65% of the recommended N and P rate of maize respectively. However, not all nutrients are available immediately for the crop uptake; i.e. the unavailable nutrients are expected to be slowly available both during the current growing season to the crop to which it is applied as well as to subsequent crops through residual effect. Similar finding was reported by Wakene et al. (2001 a and b).

3.3. Growth of Maize in Response to Integrated Fertilizer Application

Data regarding plant height showed that except 2010 at Chifisa, maize plant height was significantly influenced by fertilizer application. During 2009, application of compost with 50kg urea/ha in both locations gave the tallest plant height which was 196.3 cm and 173.95cm at Chifisa and Dendo Ofa, respectively (Table 4). During 2010, the tallest plant height (203.5cm) at Dendo Ofa was recorded from compost with 25kg urea /ha. The two years data over two locations revealed that shortest plant height was recorded from unfertilized plot which was followed by sole compost application. Although variations in plant height due to treatments on maize were noticed, the integrated fertilizer application that gave the tallest plant height was statistically at par with the blanket application of inorganic fertilizer. The finding in this experiment is in agreement with Makinde (2007), Rajeshwari et al. (2007), and Ayoola and Makinde (2009) who reported better plant height of maize on integrated fertilizer; and Ahemed et al. (2007) reported same on sorghum.

An increase or decrease in the number of leaves per plant has a direct bearing effect on the yield of crops. The mean values regarding leaf number per plant showed that except 2010 at Chifisa, number of leaves per plant was significantly influenced by fertilizer application. During 2009, application of compost with 50kg urea/ha in both locations gave the highest leaf number plant which was 14.15 and 13.60 at Chifisa and Dendo Ofa, respectively

(Table 4). These treatments, however, were statistically at par with inorganic and integrated fertilizer applications except application of compost with 25kg urea /ha at Chifisa. During 2010, highest leaf number plant-1 (13.3) at Dendo Ofa was recorded from the application of compost with 25 and 75 kg/ha of urea; and inorganic fertilizer. However, it was statistically at par with the application of compost with 50 kg/ha of urea. The two years result over two locations in general revealed that the least leaf number plant-1 was attained on unfertilized and sole compost treatments. The higher leaf number per plant on integrated and inorganic fertilizers might be due to readily availability of nutrients during the growth period of the crop. Similarly, an increase in number of leaves per plant on maize due to integrated nutrient application was reported by Makinde (2007) and Rajeshwari et al. (2007).
Application of fertilizer at two locations during 2009 and 2010 showed significant variation on leaf area index (LAI) of maize. During 2009, the highest LAI (2.85) were recorded from compost with 50kg urea/ha; and compost with 75kg urea/ha at Dendo Ofa and Chifisa, respectively (Table 4). In the mean while, statistically lowest LAI was recorded from sole compost and control. At Dendo Ofa application of compost with 50kg urea/ha resulted in 45.1% more LAI than sole compost. Similarly, compost with 75kg urea/ha at Chifisa resulted 33.7% more LAI over the control. On the other hand, the result in 2010 showed that highest LAI (2.93) at Dendo Ofa was observed on compost with 50 and 75kg urea/ha (Table 4). The value was statistically similar with inorganic and integrated fertilizer applications. In addition, in 2010, the highest LAI (3.30) at Chifisa was recorded from the inorganic fertilizer application; however, the value was statistically at par with the integrated fertilizer applications. The two years result at two locations generally indicated that highest LAI was attained through integration of compost with inorganic fertilizer; in contrast the least LAI was achieved on sole compost and control treatments. The higher LAI could be related to more number of leaves and higher leaf area per plant. Similarly, Makinde (2007) and Rajeshwari et al. (2007) on maize reported highest leaf area per plant and LAI on the combined rates of compost with inorganic fertilizers.

Biological yield is one of the measures of plant growth and it reflects the relative growth rate as regard to net assimilation rate (Khan et al., 2008). Biological yield was significantly affected by the application of fertilizer at two locations during 2009 and 2010. During 2009, maximum biological yield which was 21.57 tons/ha at Dendo Ofa and 19.28 tons/ha at Chifisa were recorded from the integration of compost/ha plus 50kg urea/ha (Table 4). The result obtained at Dendo Ofa and Chifisa during 2009, showed 52.76% and 55.65% higher biological yield over 10.19 ton ha-1and 8.55ton ha-1, which were recorded from sole compost and control treatments, respectively. However, the inorganic and the integrated fertilizers (except compost with 25kg urea/ha) were statistically at par with the maximum biological yield (Table 4). Data regarding 2010 showed that integrating compost with 75kg ha-1 urea at Dendo Ofa produced maximum biological yield (14.04 ton ha-1) which was 48.08% higher compared to the minimum (7.29 ton ha-1) from the control; whereas, at Chifisa the maximum yield (17.78 ton ha-1) which was 47.35% higher compared to minimum (9.36 ton ha-1) on sole compost application was recorded (Table 4). The result in general indicated statistically similar performance of biological yield of maize on the integrated and inorganic fertilizer applications. Furthermore, sole compost and control plots had shown lower biological yield. These result indicated that the yield of biological mass mostly reflected in response to the combined application of fertilizers. Data regarding stalk yield during 2009 and 2010 at both locations generally followed the trend of biological yield (Table 4). The increase in biological and stalk yield could reflect the better growth and development of maize plants due to balanced and more available nutrients throughout the growing period. This result was in agreement with Khan et al., (2008).

Ear weight plant-1 and cob weight plant-1 revealed significant differences due to fertilizer applications on trial sites and years. During 2009, the maximum ear weight plant-1 (333.25gm at Dendo Ofa) and (279.66 gm at Chifisa) were obtained by integrating compost with 75kg urea ha-1 and compost with 50kg urea ha-1, respectively. In the mean while, the maximum cob weight plant-1 was 286.38 gm and 240.78gm at Dendo Ofa and Chifisa, which were recorded from compost with 75kg urea ha-1and compost with 50kg urea ha-1, respectively (Table 4). During 2009, the maximum ear and cob weight plant-1 were statistically at par with inorganic fertilizer application. Similarly, data in 2010 indicated that integration of compost with 25kg urea ha-1at Dendo Ofa showed maximum ear and cob weight plant-1, however it was statistically at par with inorganic fertilizer application; whereas the least performance was recorded from non fertilized treatment in which it was statistically at par with sole compost application (Table 4). On the other hand, the highest ear and cob weight plant-1 in Chifisa were obtained from the inorganic fertilizer application. However, it was statistically at par with integrated fertilizer application except compost with 50 kg urea ha-1 (Table 4).

3.4. Yield Components & Grain Yield in Response to Integrated Fertilizer Application

3.4.1. Yield Components

Cob length is an important yield contributing parameter of maize. It substantially contributes to grain yield of maize by influencing both numbers of grains per cob and grain size. Cob lengths of maize at two locations during

2009 and 2010 were significantly affected by fertilizer application. During 2009, the maximum cob length (16.96 cm and 16.5cm) which was 37.97% and 43.03% higher than sole compost (10.51cm) and the control (9.40cm) were recorded from inorganic fertilizer at Dendo Ofa and Chifisa, respectively (Table 5). During 2010, maximum cob length (17 cm) at Dendo Ofa which was 29.41% more than sole compost (12cm) application and control (12cm) were recorded from compost supplemented with 75kg urea ha-1; whereas, at Chifisa maximum (18cm) which was 36.11% higher than sole compost (11.5cm) was recorded from the inorganic fertilizer (Table 5). In general, the two years data at both locations showed statistically similar and lower performances of sole compost and unfertilized treatments compared to integrated and inorganic fertilizer application. The reason of more cob length may be due to more photosynthetic activities of the plant on the account of adequate supply of nitrogen in these treatments. Nitrogen is an essential requirement of cob growth. A typical view of maize cob is that it serves as a temporary storage organ and as a conveyor of nutrients to the developing kernels (Crawford et al. cited in khan et al., 2008). Therefore, the better the development of cob length will be the index of the better economic yield of maize (khan et al., 2008). The result in this experiment was in agreement with khan et al., (2008) and Rajeshwari et al. (2007), who reported a significant increase in cob length with increasing rates of nitrogen fertilizer from different sources.

Data regarding number of rows per cob showed that except 2010 at Chifisa, it was significantly influenced by fertilizer application. During 2009, the highest number of rows cob-1 (17 and 16.5) were recorded at Dendo Ofa and Chifisa from the integration of compost with 75 and 50 kg ha-1 urea, respectively; whereas, during 2010, the highest number of rows cob-1 (15.75) at Dendo Ofa was recorded from compost supplemented with 25 kg ha-1 urea (Table 5). In the mean while, statistically lowest value of rows per cob was recorded from sole compost and control treatments. Besides, the numbers of grains per row at two locations during 2009 and 2010 were significantly influenced by fertilizer rates. During 2009, crops treated with compost with 75 kg ha-1 urea at Dendo Ofa gave the maximum number of grains per row (33.58); however it was statistically at par with inorganic and integrated fertilizer applications. In the mean while, at Chifisa maximum number of grains per row was recorded from compost with 50 kg ha-1 urea. Data during 2010 also revealed that maximum numbers of grains per row (29 and 37) were obtained at Dendo Ofa and Chifisa from compost with 75 kg ha-1 urea; and inorganic fertilizer application, respectively (Table 5).Similar to other parameters, statistically the least number of grains per row at two locations during 2009 and 2010 were recorded from sole compost and control treatments. Furthermore, the total number of grains per cob at two locations during two trial years was significantly influenced by fertilizer treatments. During 2009, the highest number of grains per cob (570.78 and 548.25) at Dendo Ofa and Chifisa were obtained from compost with 75 kg ha-1 and 50 kg ha-1 urea application, respectively (Table 5); whereas, during 2010, the highest number of grains per cob (422.75 and 567.17) at Dendo and Chifisa were recorded from compost with 25 kg ha-1 urea and inorganic fertilizer respectively. Statistically the least number of grains per cob at two locations during 2009 and 2010 trials were recorded from sole compost and control treatments.

3.4.2. Grain Yield

Grain yield is the end result of many complex morphological and physiological processes occurring during the growth and development of crop (Khan et al., 2008). Significant influence ($P<0.001$) on the grain yield of maize due to fertilizer application was recorded during 2009 and 2010 at two trial locations. During 2009, the maximum grain yield (6.95 and 6.53 ton ha-1) at Dendo Ofa and Chifisa was obtained from compost supplemented with 75 and 50 kg ha-1 urea, respectively. The maximum grain yield was 54.39% higher over the control (3.17 ton ha-1) at Dendo Ofa; and 52.83% more than the control (3.08 ton ha-1) at Chifisa (Table 5). During 2010, the maximum grain yield (6.05 ton ha-1) which was 50.74% more than the lowest yield from sole compost (2.98 ton ha-1) was recorded at Dendo Ofa from compost plus 75 kg ha-1 urea; whereas, in Chifisa inorganic fertilizer gave maximum grain yield (6.79 ton ha-1) which was 49.04% higher than the lowest grain yield (3.46 ton ha-1) obtained from sole compost.

In general, statistically similar performances have been observed between inorganic and integrated fertilizers. On the other hand, sole compost and control treatments at two locations and trial years produced significantly lowest grain compared with other fertilizer applications. The increase in grain yield was mainly due to better growth and yield attributing factors, better nutrient use efficiency and better grain development. Ayoola and Makinde (2006), reported higher nutrient use efficiencies with the combined organic and inorganic fertilizer applications; and also they reported similar maize yield between inorganic N fertilizer and enriched organic fertilizer with inorganic nitrogen. The result in this experiment was also in agreement with Shah and Ahmad (2006), who reported higher grain of wheat in the treatments receiving an integration of inorganic and organic fertilizer. Similarly, Ahmad et al. (2006), on maize found statistically similar grain yield between (enriched compost and 50% of recommended N fertilizer) and inorganic fertilizer. Furthermore, Abunyewa et al. (2007) found higher maize grain yield from smaller amounts of manure plus light fertilizer application than sole heavy fertilizer application which was due to the efficiency in terms of crop utilization and sustainable productivity. In addition, Rajeshwari et al. (2007) also noticed higher yield from the integrated fertilizer application.

4. Conclusion

Soil analysis before sowing indicated that the major nutrients (N, P) were found at low levels. In addition, compost analysis showed that considerable amounts of N and P nutrients were supplied by compost. The field result indicated that integrated compost application revealed a significant influence ($P<0.001$) on growth, yield components and yield of maize. However, it was statistically at par with inorganic fertilizer application. In the mean while, sole compost application and unfertilized plots showed least performance on growth, yield component and grain yield of maize. In conclusion, combined use of compost with inorganic fertilizer at (5ton/ha + 50kg urea/ha + 100kg DAP/ha) has been suggested to obtain better yield of maize and improving properties of the soil on sustainable basis than using inorganic fertilizer alone.

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References

Abunyewa, A.A., Osei,C., Asiedu, E.K. & Safo, E.Y.(2007),"Integrated manure and fertilizer use, maize production and sustainable soil fertility in sub humid zone of West Africa", Journal of Agronomy 6(2):302-309.

Agromisa, (2005), "Agrodok-series No.8. Preparation and Use of Compost", CTA Publication.

Ahmad,R., Naseer, A., Zahir, Z.A., Arshad,M., Sultan,T., & Ullah, M.A.(2006), "Integrated use of recycled organic waste and chemical fertilizers for improving maize yield", Int. J. of Agri and Biol .8(6):840-843.

Ahmed, A., Qadir,I. & Mahmood, N.(2007), "Effect of Integrated Use of Organic and Inorganic Fertilizers on Fodder Yield of Sorghum (Sorghum bicolar L.)", Pak.J.Agri.Sci.Vol.44 (30):415-421.

Ayoola,O.T., & Makinde, E.A.(2009), "Maize growth, yield and soil nutrient changes with N-enriched organic fertilizers", African Journal of Food Agriculture Nutrition and Development. Vol.9 (1):580-592.

Havlin, J.L., Beaton, J.D., Tisdale, S.L. & Nelson, W.L.(1999),"Soil fertility and fertilizers. An introduction to nutrient management", Prentice Hall, New Jersey. 499p.

Herrera, E. (2005), "Soil test interpretations", Guide A-122. College of Agriculture and Home Economics, New Mexico State University.

Khan, H.Z., Malik M.A.,& Saleem, M.F.(2008),"Effect of rate and source of organic materials on the production potential of spring maize (Zea mays L.)", Pak.J.Agri.Sci.Vol.45 (1):40-43.

Landon, J.R. (1991),"Booker tropical soil manual. A handbook for soilsurvey and agricultural land evaluation in the tropics and subtropics". Longman scientific and technical, New York.

Makinde, E.A.(2007), "Effects of an organo- mineral fertilizer application on the growth and yield of maize", Journal of Applied Sciences Research.3 (10):1152-1155.

Pushparajah, E.(1977)," World fertilizer use manual", International board for soil research and management, Bangkok, Thailand.

Rajeshwari,R.S., Hebsur, N.S., Pradeep, H.M.& Bharamagoudar, T.D.(2007),"Effect of integrated nutrient management on growth and yield of maize", Karnataka J. Agric. Sci. 20(2):399-400.

Rizwan A., Shahzad, S.M., Khalid, A., Arshad,M. & Mahmood, M.H.(2007), "Growth and Yield response of (Triticum aestivium L.) and Maize (Zea mays L.) to nitrogen and L-tryptophan enriched compost", Pakistan J. Bot., 39(2):541-549.

Sahlemedhin, S. & Taye B. (2000), "Procedures for Soil and Plant Analysis", National Soil Research Center, EARO, Technical Paper No. 74, Addis Ababa, Ethiopia.

Sahlemedihin, S.(1999), "Draft guideline for regional soil testing laboratories", NFIA, Addis Ababa, Ethiopia.

SAS (Statistical Analysis System). (1997),"Statistical Methods", SAS Institute. Inc., Cary, N.C., U.S.A.

Shah, Z., & Ahmad. M.I.(2006),"Effect of integrated use of farm yard manure and urea on yield and nitrogen uptake of wheat", Journal of Agricultural and Biological Sciences,Vol.1 (1):60-65.

SNNPRS (Southern Nation, Nationalities, and People Regional State). (2007),"Regional Statistical Abstract 1998E.C (2005-06)", Bureau of Finance and Economic Development, Division of Statistics and Population, Awassa, Ethiopia.

Tolera, A., Tamado T. & Pant, L.M.(2005),"Grain yield and LER of maize-climbing bean intercropping as affected by inorganic, organic fertilizers and population density in Western Oromia, Ethiopia" Asian Journal of Plant Sciences.4 (5):458-465.
Tenaw, W., Husni, M.H.A., Anuar, A.R. & Rahman. Z.A.(2006),"Effect of coffee residue and intercropping on soil physicochemical properties and yield of component crops in Southern Ethiopia", Ethiopian Journal of Natural Reesources.8 (2):199-216.
Wakene, N., Kefyalew N, Frriesen, D.K., Ransom, J. & Abebe Y. (2001a), "Determination of optimum farmyard manure and NP fertilizers for maize on farmers' fields", Seventh Eastern and Southern Africa regional maize conference. Pp. 387-393.
Wakene, N., Tolera, A., Frriesen, D.K., Abdenna D., & Berhanu, D. (2001b), "Evaluation of Compost for maize production under farmers' conditions", Seventh Eastern and Southern Africa regional maize conference. Pp. 382-386.
Wondwosen, T.(2009),"Identification of growth limiting nutrient(s) in the major soil types of Kindo Koye and Delbo Atwaro watersheds", Woliaita zone, Southern Ethiopia. In: CIDA/UPCD Sustainable rural agriculture development project research Abstract collections, Hawassa University. P.26.

Table 1. Selected physico-chemical properties of experimental sites before treatment application (Chifisa and Dendo Ofa), 2009 and 2010.

Soil properties	**2009**		**2010**	
	Chifisa	Dendo Ofa	Chifisa	Dendo Ofa
Textural class	Sandy Clay loam	Sandy loam	Loam	Sandy Loam
pH	6.0	6.9	6.4	7.3
TN (%)	0.15	0.13	0.06	0.07
OC (%)	1.52	1.4	0.75	0.87
Available P (mg Kg^{-1})	2.20	3.10	9.1	5.1
EC (dSm^{-1})	nil	nil	nil	nil

Table 2. Soil pH, EC, total N (TN), Organic Carbon (OC), and available P after treatment application (Chifisa and Dendo Ofa), 2009 and 2010.

Trt	pH		TN (%)		OC (%)		Available P (mg Kg^{-1})	
	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo
				2009				
1	5.85	6.9	0.16	0.10	1.61	1.10	2.8	3.82
2	5.88	7.15	0.14	0.12	1.46	1.04	3.8	4.17
3	6.08	6.98	0.15	0.13	1.75	1.24	3.18	3.67
4	5.83	6.73	0.14	0.11	1.66	1.21	2.93	4.21
5	5.93	6.88	0.12	0.13	1.52	1.13	2.68	3.68
6	5.98	6.70	0.18	0.12	1.49	1.37	3.01	3.86
				2010				
	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo
1	6.50	7.20	0.158	0.053	2.03	0.86	1.97	2.99
2	6.53	7.43	0.143	0.058	1.80	0.89	2.53	3.29
3	6.63	7.43	0.160	0.053	2.03	0.83	3.03	3.10
4	6.53	7.53	0.160	0.045	2.07	0.85	1.73	3.11
5	6.55	7.33	0.160	0.048	2.01	0.77	3.33	3.84
6	6.45	7.33	0.153	0.050	1.97	0.81	2.10	2.70

Key: 1= No fertilizer, 2=100 kg urea/ha +100kg DAP/ha 3=5t compose/ha 4=5t compost/ha+25kg/ha urea + 100kg DAP/ha, 5 =5t compost/ha+50kg/ha urea + 100kg DAP/ha 6 =5t compost/ha+75kg/ha urea + 100kg DAP/ha,

Table 3. Total N (%) and available P (mg kg^{-1}) of compost across year and their amount in kg/ha

Year	Total N (%)	Total N (Kg/ha)	Available P (mg kg^{-1})	Available P (Kg/ha)
2009	0.6	30	10.3	0.052
2010	0.27	13.5	25.5	0.129

Table 4. Growth attributes of maize as influenced by integrated fertilizer at two locations (Chifisa and Dendo Ofa), 2009 and 2010.

TRT	Plant Height (Cm)		LNPP		LAI		Biological yield (t/ha)		Ear wt plant^{-1} (gm)		Cob wt Plant^{-1} (gm)	
	2009											
	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa
1	129.2c	126.44d	12.35bc	11.20c	1.64d	1.66d	11.22c	8.55c	186.03c	112.51b	163.84c	95.43c
2	158.6ab	179.05abc	13.6a	13.35ab	2.52b	2.56ab	20.08a	18.30a	317.15a	267.22a	274.90a	229.78a
3	133.35bc	157.27c	12.1c	13.36c	1.41d	1.83cd	10.19c	8.55c	165.99c	120.35b	144.22c	101.00c
4	141.44bc	171.13bc	13.64a	12.67b	2.13c	2.22bc	15.47b	13.92b	251.43b	260.56a	223.83b	173.65b
5	173.95a	196.30a	14.15a	13.60a	2.85a	2.80a	21.57a	19.28a	326.54a	279.66a	280.72a	240.78a
6	173.47a	188.85ab	13.47ab	13.45a	2.50b	2.85a	20.61a	16.98ab	333.25a	251.19a	286.38a	217.06ab
LSD $_{0.05}$	25.27	23.63	1.13	0.77	0.32	0.53	2.81	4.36	49.08	77.34	41.38	53.63
CV %	11.06	9.23	5.69	4.05	9.75	15.08	11.29	20.20	12.36	23.84	11.99	20.19
	2010											
	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa
1	147.5b	199.25	11.8b	12.75	1.93b	2.49b	7.29b	9.91c	93.36b	125.13c	74.96b	104.5c
2	187a	205.00	13.3a	13.25	2.87a	3.30a	12.27a	17.78a	164.42a	239.54a	135.21a	202.0a
3	164.8a	228.75	12b	13.0	2.12b	2.29b	7.52b	9.36c	94.21b	127.96c	75.0b	108.9c
4	203.5a	219.25	13.3a	13.25	2.72a	3.22a	13.85a	15.02ab	177.25a	198.21ab	144.13a	166.2ab
5	195.3a	215	12.8a	13.0	2.93a	2.96a	12.33a	14.60b	163.67a	190.67b	134.79a	158.7b
6	196.8a	224	13.3a	12.75	2.93a	3.21a	1 4.04a	15.79ab	174.42a	203.79ab	143.07a	171.3ab
LSD $_{0.05}$	19.2	NS	0.63	NS	0.44	0.38	2.69	3.07	43.95	46.6	37.9	39.75
CV %	6.95	13.4	3.29	4.29	11.42	8.59	15.9	14.85	20.2	17.07	21.3	17.36

Note: means with the same letters are not significant

Key: 1= No fertilizer, 2=100 kg urea/ha +100kg DAP/ha 3=5t compose/ha 4=5t compost/ha+25kg/ha urea + 100kg DAP/ha 5 =5t compost/ha+50kg/ha urea + 100kg DAP/ha, 6 =5t compost/ha+75kg/ha urea + 100kg DAP/ha

Table 5. Grain Yield and yield components of maize as influenced by integrated fertilizer at two locations (Chifisa and Dendo Ofa), 2009 and 2010.

Trt	Cob length (cm)		No of Rows per cob		No of Grains per Row		No. of Grains per cob		Grain yield(t/ha)	
	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa
					2009					
1	11.94c	9.40d	15.24c	14.56b	22.80c	18.11c	347.79c	263.67c	3.17c	3.08c
2	16.96a	16.50a	16.18b	15.75a	31.89ab	33.25a	515.38a	524.00a	6.38ab	6.41a
3	10.51c	10.04d	15.00c	14.22b	21.18c	20.00c	317.67c	292.44c	3.83c	3.17c
4	14.49b	12.56c	15.22c	16.56a	28.38b	26.33b	432.64b	436.11b	5.80b	5.15b
5	16.70a	16.00ab	16.50b	16.50a	32.25a	33.25a	531.25a	548.25a	6.70ab	6.53a
6	16.85a	14.75b	17.00a	16.00a	33.58a	29.75ab	570.78a	476.00ab	6.95a	5.99ab
LSD $_{0.05}$	1.56	1.56	0.44	0.83	4.81	4.69	73.04	79.09	1.04	1.24
Cv %	7.08	7.86	1.85	3.55	11.27	11.63	10.71	12.39	12.58	16.22
					2010					
	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa	Dendo	Chifisa
1	12.0b	12.0c	13.5b	15.25	17.75b	23.5b	235.25b	356.25b	3.04b	3.47c
2	16.5a	18.0a	15.25a	16.00	25.75a	37.0a	397.25a	567.17a	5.95a	6.79a
3	12.0b	11.5c	14.0b	15.75	19.0b	22.5b	259.75b	348.50b	2.98b	3.46c
4	16.5a	16.0b	15.75a	15.00	27.25a	33.0a	422.75a	487.50a	5.58a	5.35b
5	15.5a	15.75b	15.0a	15.50	27.25a	31.75a	389.75a	500.75a	5.49a	5.36b
6	17.0a	17.0ab	15.0a	15.50	29.0a	35.25a	416.75a	546.0a	6.05a	5.86ab
LSD $_{0.05}$	2.47	2.0	0.93	NS	5.47	5.59	98.34	82.72	1.33	1.31
Cv %	10.12	8.80	4.17	5.04	14.91	12.17	18.45	11.74	18.22	17.20

Note: means with the same letters are not significantly different (ns)   ns=not significant difference

Key: 1= No fertilizer, 2=100 kg urea/ha +100kg DAP/ha 3=5t compost/ha 4=5t compost/ha+25kg/ha urea + 100kg DAP/ha 5 =5t compost/ha+50kg/ha urea + 100kg DAP/ha, 6 =5t compost/ha+75kg/ha urea + 100kg DAP/ha