Integrated Effect of Compost and Nitrogen Fertilizer on Maize (*Zea mays* L.) Growth and Yield at Toke Kutaye District, West Shoa Zone, Ethiopia

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Abstract

Field experiment was conducted at Toke Kutaye District on farmer's field at Birbirsa and Dogoma Kebele (lowest administrative unit) in 2015 main cropping season to determine the effect of compost integrated with nitrogen fertilizer. The experiment was laid out in randomized complete block design with three replications in factorial arrangement with four different rates of nitrogen fertilizer (0, 25% rec., 50% rec. and100% rec. or 0kg/ha, 23kg/ha, 46kg/ha and 92 kg/ha, respectively) and three levels of compost (0, 7.5 and 15t ha^{-1}). Results showed that the main effect of compost significantly (P≤0.05) affected days to 50% tasseling, 50% silking, and 90% maturity, plant height, leaf area index, number of ears per plant, ear length, thousand kernels weight, and number of kernels per ear. Main effect of nitrogen significantly affected plant height, number of ears per plant, 1000-seed weight, dry biomass and grain yield. Moreover, the interaction effect of nitrogen and compost significantly (P≤0.05) influenced the number of kernels per ear, thousand seed weight, dry biomass and grain yield. Moreover, the highest dry biomass (16492.9 kg/ ha) and grain yield (8299kg/ ha) were recorded in the treatment that received 50% recommended N fertilizer combined with 15t/ha compost. Grain yield correlated positively with maize growth and yield components parameters. Based on the study findings, it is suggested that integrated use of N fertilizer at the rate of 50 % recommended combined with compost at 15t/ha had the potential to significantly increased maize yield in the study area.

Keywords: Compost, inorganic fertilizer, integrated nutrient management, maize

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop in the world after wheat and rice with respect to area coverage and productivity (Arunkumar, 2007). It remains one of the most widely grown cereals in the world and has great significance as human food, animal feed and raw material for large number of industrial products.

In Ethiopia, According to CSA (2013), maize is the first and second crop in terms of production and area coverage followed by and next to teff (*Eragrostis tef* Zucc.), accounting for 26.6% (6,158,317.6 t and 16.4% (2,730,272.9 ha) respectively with an average yield of 3.1 t ha^{-1}. Global production exceeds 600 metric tons (McDonald and Nicole,2005), with about 60% produced in the developed countries, particularly the United States of America, China produces 27% of the world's maize and the rest by countries in Africa, Latin America, and Southern Asia with a large proportion being produced in the tropics and subtropics. Khan *et al.*,

(2008) reported maize to be the most important food and cash crop for millions of rural farm families in the predominantly mixed crop-livestock farming systems in Africa.

Despite the large area under maize production, the national average yield of maize in Ethiopia is about 2.95 t/ha (CSA, 2012). This is below the world's average yield of 5.21t/ha (FAO, 2011). The major constraints for maize production and productivity being the lack of sufficient nutrient inputs (mainly N, P and K), soil chemical constraints (e.g., soil acidity), soil physical constraints, frequent drought or suboptimal rainfall conditions, lack of high potential germplasm, declining soil fertility, limited use of inputs (Abreha *et al.*, 2013), insufficient technology generation, lack of credit facilities, poor agronomic practice, and/or pests and diseases (Denning *et al.*, 2009; Kihara *et al.*, 2010).

Small holder farming systems in Africa is reportedly lacking in sustainability mainly due to factors such as nutrient losses by soil erosion, lack of soil fertility restoring inputs and unbalanced nutrient mining (Hirpa *et al.*, 2009). Achieving high maize yield requires adequate and balanced supply of plant nutrients (Barbieri *et al.* , 2008)

From all plant nutrients, N fertilizer rates deserve highest attention because of nitrate leaching, volatilization of N_2O (green house) and affect the farmers' profit, and too low rates was also depress the profit (Mengel *et al.*, 2006). Maize is a heavy feeder of N. It responded the highest yield by applying higher N fertilizer (Ermias *et al.*, 2007). However, most agricultural soils are deficient in N for growing maize as it were lost by leaching, erosion, gaseous emissions or denitrification. Accurate N fertilizer recommendations for maize production are important for maximizing productivity and minimizing the environmental impacts (Miao *et al.*, 2007). The high price of inorganic fertilizers which is beyond the reach of poor farmers; and the limited availability, low nutrient composition and high labor requirement of organic fertilizers are among the contributing factors for the low provision as per the crop nutrient requirement over large area (Abera *et al.*, 2005).

Generally, sole uses of chemical fertilizers cause deterioration in soil physico-chemical and biological properties (Kidist, 2013). However, owing to the higher fertilizer cost and withdrawal of fertilizer subsidy by the government, farmers could not apply chemical fertilizer in appropriate rate and methods. This contributed for a continuous decline of maize yield. Hence, combined use of organic (i.e. compost) with nitrogen fertilizers has considerable contribution to improve soil fertility and boost production. Numerous studies (Geremew, 2010; Abedi *et al.*, 2010) reported the positive outcomes of integrated nutrient management in many areas. Indeed very few studies have been carried out on integration of nitrogen and compost fertilizers rates on maize production in the study area. Therefore, the objective of this study was to evaluate the effect of compost and N fertilizers rates, and their integration on growth, and yield of maize and to determine the optimum combinations of compost and nitrogen fertilizers for maize production in the study area.

Materials and Methods

Description of the Study Area

The study was carried out on farmers' field at Guder, Toke Kutaye District during the 2015 cropping season. Guder is located 12 kilometers west of Ambo. The District lies at 8^0 58"N latitude and 37^0 46"E longitudes with an elevation ranging from 1600 to 3192 meter above sea level. The mean annual rainfall recorded at the station was 1045 mm and the average annual minimum and maximum temperatures are 8.9 and 27.4°C, respectively. (OBOFED, 2015).

Treatments and experimental design

The treatments comprised of four levels of nitrogen (0, 25, 50, and 100% of recommended N) equivalent to 0, 23, 46 and 92 kg N ha^{-1}, respectively) and three levels of compost (0, 7.5 and 15 tons ha^{-1}) which were laid out in randomized complete block design (RCBD) in factorial arrangement with three replications.

The field was ploughed following the conventional farmers' practices with oxen and divided into small plots of 3.2 m x 3m (9.6 m^2), with an inter and intra row spacing of 80 cm and 50 cm, respectively. Maize variety AMH851 hybrid (Jibat) released by Ambo Plant Protection Research Center through the National Maize Research Programmed in 1998 was used for the study. Three seeds were sown per hill on July 3/2015 and later thinned to two plants. Nitrogen fertilizer in the form of urea (46% N) and phosphorus in the form of Triple Super Phosphate (TSP) were used in the study. The N fertilizer was split (half at planting and the remaining half given at knee height) while phosphorus was basal applied at planting. For plots receiving compost, it was applied and incorporated into the soil three weeks before planting as per the recommendations of (Fernandez *et al*., 1995). All agronomic practices were undertaken as per the treatment and recommendation to all experimental plots as required uniformly. The compost used in the study was prepared as per the farmers' practices from decomposable crop residue materials three months before planting.

Soil sampling and analysis

Representative surface soils of the site were diagonally collected from 0-20 cm soil depth and composited before treatment application. The soil was air-dried at room temperature for 5 days and crushed to pass through a 2mm mesh sieve. Both soil and prepared compost were analyzed for;

OC, total N, CEC and available P and pH in the Chemistry laboratory of Ambo University. Organic carbon was determine by Walkley and Black (1934), total N by Kjedahl digestion method (Jackson, 1958), available P (Olsen *et al.*, 1954) and pH was measured in 1:2.5 suspension ratio of both the soil and compost to potassium chloride (KCl) solution as described by Chopra and Kanwar (1976). Cation exchangeable capacity was determined using ammonium acetate method (NH_4OAc) (Chapman, 1965).

Data collection

Data collected include phonological parameters such as Days to 50% tasseling, days to 50% silking and days to 90% physiological maturity. Growth data recorded includes plant height, number of leaves per plant, leave area and leaf area index. Leaf area was calculated as the product of leaf length and width multiplied by a correction factor of 0.75 (Francis et al., 1969).

Yield data recorded includes number of ears per plant (cm), number of kernels per ear and thousand seed weight, Cob length, number of rows/cobs, dry biomass yield, grain yield and harvest index. Data recording was made from randomly selected five plants from the plots. Grain yield was adjusted to 12.5% moisture content

Data analysis

The data collected were subjected to analysis of variance (ANOVA) using statistical analysis systems (SAS) software (SAS, 2002). Where treatments showed significant difference, least significant difference (LSD) test at 5% probability was used to compare treatment means.

Results and Discussion

Soil physicochemical analysis of the study site before planting and after harvesting

Soil properties before planting

The initial soil analysis results indicated that the major nutrients (N, P) were not adequate in the soil for optimum maize growth, and the soil can be described as clay loam, the soil pH was acidic (5.8), which is within the range for most crops. The organic carbon content of the site was 1.4% with an average organic matter content of 2.44% which according to Berhanu (1980) is categorized as low, indicating moderate potential of the soil to supply nitrogen to plants through mineralization of organic carbon. The average total N of the study site was 0.1313%. According to Landon (1991) this value is low. The result also indicated that the available phosphorous (P) content in the study area were (10.85ppm) which according to Tekalign (1991) can be described as being in the medium category. Moreover, The CEC value of the soil sample before sowing was low (13.6cmol kg^{-1}soil), indicating its low capacity to retain the cations.

Soil properties after harvesting

The after harvesting analysis of the soil samples showed an improvement in the soil chemical properties; soil pH (5.95), organic carbon content (6.43%), organic matter content (11.1%), total N (0.64%), available P (17.6), and a cation exchange capacity of 28.7 cmol (+) kg. This improvement could be attributed to the residual effect of compost.

The initial analysis of the compost used showed the nutrient composition as having a pH of 7.22, total nitrogen (1.26%), organic carbon (11.35%), organic matter (19.6%), available phosphorous (38.76 ppm) and a CEC of 44 cmol (+) kg indicating the quality of the compost, though the micronutrient content was not analyzed.

Phenological Parameters

Days to 50% tasseling

The analysis of variance result showed that the main effects of applied N rates and compost were significant (P≤0.05) in affecting the days to 50% tasseling of maize. However, the interaction of N and compost was not significant. It was observed that nitrogen fertilizer increased the duration of tasseling of maize. As the rate of fertilizers increased from 0 to 100% rec N fertilizer or 92kg/ha N there was consistent increase in the days to 50% tasseling from 82.4days to 90.2 days respectively (Table 1). Geremew (2010) had reported that excess application of nitrogen delay crop phenological parameters which corroborates this study finding. The result is also in line with the finding of Imran *et al.,* (2015) and Kawsar *et al.,* (2012)

Days to 50% silking

The analysis of variance result indicated that days to 50% silking was significantly (P≤0.05) affected by the main effect of nitrogen and compost (Table 4). Days to 50% silking increased from 87.4 to 93.3 days with increase in the rate of nitrogen from 0 to 100% recommended N. Delayed silking as a result of higher N rates could be attributed to the vigorous vegetative growth and increased light use efficiency for photosynthesis. This result agrees with that of Imran *et al.,* (2015) who reported increasing N application delayed silking in maize by 5 days. Amanullah *et al.,* (2009) also reported that maize took more time to tasseling, silking and physiological maturity with higher N rates.

Days to 90% maturity

The main effect of compost and nitrogen was found to be highly significant (P≤0.01) and (P≤0.05) on days to 90% maturity (Table 4). Whereas the interaction effect of compost and nitrogen were not significant for days to 90% maturity. The days to maturity increased from 163.9 to 169.6 days and 158.2 to174.03 days with increase in compost rates from 0 to 15t ha^{-1} and N rates from 0 to 100% recommended N fertilizers, respectively (Table 4). This might be attributed to possible increase in nutrient availability and moisture retention with increasing compost rate. These result collaborated by that of Akbar *et al.,* (2002) reported increase in days to maturity of maize as fertilizer rate was increased.

Table 1. Main effects of compost and nitrogen rates on days to 50% tasseling, 50% silking and days to 90% maturity of maize at Guder in 2015

Treatment	Days to 50% tasseling	Days to 50% silking	Days to 90% maturity
Compost rate(t/ha)			
0	84.6[c]	87.3[c]	163.91b
7.5	85.98[b]	90.4[b]	165.8[b]
15	87.78[a]	92.88[a]	169.6[a]
LSD(0.05)	1.085	1.49	2.36
Nitrogen rate			
0	82.4[d]	87.4[c]	158.2[d]
25% rec	84.7[c]	88.8[c]	164.2[c]
50% rec	87.2[b]	91.24[b]	169.2[b]
100% rec	90.2[a]	93.3[a]	174.03[a]
LSD(0.05)	1.6	1.73	2.72
CV (%)	1.6	1.96	1.67

Means in column followed by the same letters are not significantly different at 5% level of significance

Effect of Compost, Nitrogen and their Interaction on the Growth of Maize Plant height and number of green leaves/plant

The analysis of variance result indicated a highly significant ($P \le 0.05$) main effect of N and compost on plant height and number of green leaves/plant whereas their combine application had no effect on the two parameters (Table 2). The application of compost increases plant height with increasing rate of compost showing significant difference between the control (1.91m) and the highest compost application rate of 15t /ha (2.25m) (Table 2). The same trend was observed with nitrogen, where mean values indicated that maize plant height increased with each increment in nitrogen from control (0 kg ha^{-1}) to the highest rate (100% recommended N). The tallest plant (2.22 m) was recorded in plots treated with 100% recommended N and the control plots recorded the shortest (1.88 m) plant height (Table 2). This could be attributed to increase nutrient availability as the rates were increased. Adeniyan (2014) had reported that increased compost and N application rate leads to maximum vegetative growth of the plants due to higher N availability. These results agrees with that of Adekayode and Ogunkoya (2010) who reported a very high significant differences in maize plant height in plots treated with high fertilizers compared to the control.

Table 2. Main effects of compost and nitrogen rates on plant height and number of green leaves per plant of maize at Guder in 2015

Compost rate (t /ha)	Plant height	Number of green leaf per plant
0	1.91[b]	11.87[c]
7.5	2.04[b]	12.9[b]
15	2.25[a]	14[a]
LSD(0.05)	0.142	0.86
Nitrogen rate		
0	1.88[c]	11.29[c]
25% rec	2.03[bc]	12.31[b]
50% rec	2.13[ab]	13.8[a]
100% rec	2.22[a]	14.3[a]
LSD(0.05)	0.164	0.99
CV(%)	8.09	7.84

Means in column followed by the same letters are not significantly different at 5% level of significance. Rec= recommended

Similarly, the same trend was observed with number of leaves per plant, the highest number of leaves was recorded at 15t/ha compost (14) and 100% recommended N (14.3), and the lowest on the control plots (Table 2). This is also attributed to better nutrient availability and other growth contributing factors. This result agreed with Makinde (2007) and Rajeshwari *et al.,* (2007) who both reported an increase in number of leaves per plant on maize due to better nutrient availability.

Leaf Area Index

The result of leaf area index in this study showed a highly significant (P≤0.05) interaction effects of compost and nitrogen. The highest LAI (3.56) was recorded with the integrated application of 15t/ha compost with 50% recommended N fertilizer followed by 15t/ha compost + 100% recommended (3.05) which showed a decreased beyond 50% recommended (Table 3). The lowest (1.95) LAI was recorded with the control plot. The application of compost alone at 15t/ha or compost integrated with 25% recommended N produces a better LAI when compared to the control. The increase in LAI was possibly due to the improved leaf expansion as a result of N and compost application. This result corroborates the findings of Laekemariam and Gidago (2012) that reported highest leaf area per plant and LAI as a result of the integrated application of compost with nitrogen fertilizers.

Effect of Compost and Nitrogen on Maize Grain Yield and Yield Components Number of Ears per Plant and cob length

The statistical analysis of the data revealed that number of ears per plant and the cob length were compost and nitrogen effects were highly significantly (P≤0.05) affected by the main effects of compost and nitrogen only with no significant interaction effect on the parameters (Table 4).

Table 3. Interaction effect of compost and nitrogen rates on LAI of maize at Guder in 2015

Treatments	Nitrogen rate			
compost rate(t/ha)	0	25% rec	50% rec	100% rec
0	1.95^{f}	2.3^{e}	2.34^{ed}	2.85^{bc}
7.5	1.99^{f}	2.17^{ef}	2.61^{cd}	2.75^{c}
15	2.22^{ef}	2.38^{ed}	3.56^{a}	3.05^{b}
LSD(0.05)	0.272			
CV (%)	6.38			

Means in column followed by the same letters are not significantly different at 5% probability level

Table 4. Main effects of compost and nitrogen rates on number of ear per plant (NE/PLT), cob length (CL) and number of row per cob (NR/C) of maize

Treatments	Number of ear/plant	Cob length	Number of row /cob
Compost rate(t/ha)			
0	1.25^{b}	21.1^{c}	12^{a}
7.5	1.37^{b}	22.13^{b}	12.17^{a}
15	1.59^{a}	23.65^{a}	12.5^{a}
LSD (5 %)	0.224	1.03	0.855
Nitrogen rate			
0	1.02^{b}	19.47^{d}	10.7^{c}
25% rec	1.27^{b}	21.71^{c}	11.8^{b}
50% rec	1.68^{a}	24.64^{a}	12.89^{a}
100% rec	1.64^{a}	23.3^{b}	13.56^{a}
LSD(0.05)	0.258	1.19	0.99
CV (%)	18.8	5.46	8.26

Means in columns followed by the same letters are not significantly different at 5% probability level. NE/PLT=number of ear/plant, CL=cob length, NR/C=number of row/cob

The lowest numbers of ears per plant (1.02 and 1.25) were recorded at control N and compost, while the highest numbers (1.68 and 1.59) were recorded at nitrogen and compost rate of 50% rec N fertilizers and 15t/ha, respectively (Table 4). Higher rate of N fertilization resulted in higher number of ears. In general, the present result indicated that lowest number of ears per plant was observed in control plots. The result indicated that, increased in number of ears per plant due to increased nitrogen levels might be attributed to better uptake of nutrients and increased translocation of photosynthetic products from source to sink. This might be due to the fact that application of compost and nitrogen could be attributed to better growth, yield attributing components, grain development and nutrient use efficiencies due to their effects. In agreement with current result, Jalali *et al.,* (2010) reported that increase in nitrogen fertilizer application resulted in increased number of ears per plant. The result was consistent with the findings of Mahamed and Awale (2013) in which maximum number of ears per plant were attained in maize in response to the N and compost application rate.

Cob Length

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 were significantly affected by main effects while there was no interaction effect between nitrogen and compost fertilizer application. Maximum cob length 23.65 and 24.64cm was recorded at 15t/ha compost and 50% recommended N fertilizer, respectively (Table 4). Cob length was found to increase with increase application of both compost and 50% recommended N fertilizer which was statistically at par with integrated fertilizer applications and nitrogen fertilizer applied while the shortest cob length 19.47cm was recorded at control treatments and sole compost. The result of 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.

Number of Rows per Cob

Data regarding to the number of rows per cob revealed that it was significantly influenced by the treatment. The highest number of rows cob^{-1} (16.5) was recorded with the application of compost at 15t/ha and 100% recommended N fertilizer, respectively (Table 4). Meanwhile, statistically lower value of rows per cob was recorded from control plot. This might be due to the increased nitrogen and compost levels which increase nutrient availability / uptake and increased translocation of photosynthates to sink. Mahamed and Awale (2013) also obtained maximum number of rows per cob (12.50) at maximum nitrogen application. Similarly, Pandey and Chaudhary (2014) also reported that increasing nitrogen level significantly increased the number of rows per cob of maize.

Number Kernels per Ear

The interaction of compost and nitrogen fertilizers significantly ($P \leq 0.05$) affected the number of kernels per ear. The highest number of kernels per ear (542.5) was recorded when compost at 15 t ha^{-1} was integrated with 50% recommended N, while the control gave the lowest number (318) of kernels per ear (Table 5). The increase in the number of kernels per ear could be due to the contributions of compost and N for better growth and development. This result agreed with Laekemariam and Gidago (2012) who reported an obvious increase in number of grains per ear of maize when organic manures and mineral nitrogen fertilizer were applied in combination. They also reported that integration of inorganic N fertilizer with compost resulted in significantly higher number of kernels per ear.

Table 5. Interaction effect of compost and nitrogen rates on number of kernels per ear of maize

Treatments		Nitrogen rate		
compost rate(t/ha)	0	25% rec	50%rec	100%rec
0	318^{e}	354.6^{de}	395.7^{cd}	419^{bc}
7.5	351^{ed}	389.9^{cd}	450^{b}	433^{bc}
15	354de	396^{cd}	542.5^{a}	437.5^{bc}
LSD(0.05)	52.1			
CV (%)	7.63			

Means in columns followed by the same letters are not significantly different at 5% probability level

Thousand seed weight

The results showed significant (P≤0.05) interaction effect was observed between compost and nitrogen fertilizers on 1000 seed weight of maize (Table 9). Maximum thousand seed weight (460g) was recorded in plots treated with 50% recommended N fertilizer plus 15 t /ha compost (Table 6). However, compost alone, or compost integrated with 25%, 50% recommended N or N alone showed a significant difference from the control plot which recorded the lowest (265g) 1000-seed weight. Application of 100% recommended N gave the highest 1000 seed weight as compared to compost alone. The minimum 1000-grain weight recorded with compost might be attributed to delay in the release of nutrients throughout the plant life especially at the time of flowering and seed setting. Increased kernel weight with increasing compost and nitrogen levels might be due to the formation of more leaf area which might have intercepted more light and produced more carbohydrates in the source which was probably translocate into the grain. These results were in agreement with Dawadi and Sah (2012) who reported significant effect of combined application of compost and nitrogen fertilizer on 1000-grain weight of maize.

Table 6. Interaction effect of compost and nitrogen rates on 1000-seed weight of maize

Treatments		Nitrogen rates		
compost rate(t/ha)	0	25%rec	50%rec	100%rec
0	265^{g}	340.97^{def}	389.3^{bc}	436.9^{a}
7.5	300^{ef}	352^{cde}	376^{cd}	426.1^{ab}
15	316^{gf}	332^{def}	460^{a}	450^{a}
LSD(0.05)	45.8			
CV (%)	7.31			

Means in columns followed by the same letters are not significantly different at 5% probability level

Dry Biomass

The dry biomass yield was significantly (P≤0.01) influenced by the main effects of nitrogen and compost and their interaction (Table 7). The highest dry biomass (16493kg/ha) was recorded in plots that were treated with 50% rec N fertilizer plus 15 t /ha compost whiles the lowest dry biomass (4257kg/ha) was recorded in the control and unfertilized treatments. The higher dry biomass yield recorded with combined use of compost and nitrogen fertilizers could be due to adequate and balanced supply of plant nutrients by compost throughout the growth period. It could also be due to the synergistic effects of N and compost fertilizers on some growth parameters such as the LAI.

The result was in agreement with Khan *et al.,* (2008) who reported that total dry matter of maize was higher when inorganic and organic fertilizers were combined than chemical fertilizers alone.

Table 7. Interaction effect of compost and nitrogen fertilizers on dry biomass (kg/ha) of maize

Treatments		Nitrogen rate		
compost rate(t/ha)	0	25% rec	50% rec	100% rec
0	4257^{g}	5044^{gf}	6759^{ef}	9552^{d}
7.5	6352^{ef}	7659^{e}	9941^{d}	12163^{c}
15	7418^{e}	10677^{cd}	16493^{a}	14194^{b}
LSD(0.05)	1755			
CV (%)	11.26			

Means in columns followed by the same letters are not significantly different at 5% probability level

Grain Yield

Grain yield is the summation of physiological and morphological development, and these processes need to be understood in order to attain the highest grain yield. It is the final outcome of many complex processes occurring during the growth and development of crop.

The statistical analysis of maize grain yield showed a significant (P≤0.05) interaction effect of compost and nitrogen rates (Table 8). The highest mean grain yield (8298 kg/ha) was recorded in plots treated with 50% rec N fertilizer plus 15 t compost ha^{-1} while the lowest yield (983kg/ ha) was on the no compost and nitrogen application. Moreover, the application of nitrogen alone at the recommended rate showed a significantly better performance than when compost was applied alone. On the other hand, the integration of 25% rec N still gave a much better yield than the recommended 100% N (Table 8). The better grain yield with combined application could be attributed to better growth, yield attributing components, grain development and nutrient use efficiencies.

The maximum grain yield attained by the interaction of N and compost fertilizers might also be attributed to the synergistic effects of N and compost fertilizers. Higher grains yield at higher nitrogen levels might be due to the readily availability of N for the crop and the lower yield recorded when compost was applied alone, could be attributed to the slow release of available N in the compost. Makinde and Ayoola (2010) had reported high and sustainable crop yields are only possible with integrated use of mineral fertilizers with OM, which is corroborated by the findings of this study. Sue *et al.*, (2006) also reported that the use of compost combined with chemical fertilizer resulted in the production of higher yields than the yield increments obtained in response to the application of chemical fertilizer alone.

Table 8. Interaction effect of compost and nitrogen rates on grain yield (kg/ha) of maize

Treatments	Nitrogen rate			
Compost rate(t/ha)	0	25% rec	50% rec	100% rec
0	983^{h}	1461^{h}	3292^{gf}	4497e
7.5	1677^{h}	3921^{ef}	4671de	5967^{c}
15	2643^{g}	5593^{cd}	8299^{a}	7271^{b}
LSD(0.05)	928.27			
CV (%)	13.08			

Means in columns followed by the same letters are not significantly different at 5% probability level

Harvest Index

The physiological efficiency and ability of a crop for converting the total dry matter into economic yield is known as harvest index (HI). The harvest index was a measure of productive efficiency that how efficiently a crop can use its physiological inheritance. The harvest index was significantly (P≤0.01) influenced by the main effects of nitrogen and compost, and their interaction (Table 9). The highest harvest index (51.87%) was recorded in plots treated with 50% rec N fertilizer plus 15 t /ha compost whiles the lowest harvest index (23.88%) was recorded in the control and unfertilized treatments (Table 9). The comparison of treatment means showed that maximum harvest index was recorded with the combined use of fertilizers at 50% recommended N fertilizer and 15t/ha compost.

Table 9. Interaction effect of compost and nitrogen rates on harvest index (%) of maize

Treatment	Nitrogen rate			
Compost rate(t/ha)	0	25% rec	50% rec	100% rec
0	23.88^{e}	30.6^{ef}	38^{cd}	43.4^{bc}
7.5	26.5^{e}	44de	46.5^{bc}	47.3^{bc}
15	37.7^{cd}	42.1^{cd}	51.87^{a}	49.53^{b}
LSD(0.05)	8			
CV(%)	11.27			

Means in column followed by the same letters are not significantly different at 5% probability level

Correlation analysis

The correlation analysis indicated a highly significant and positive relationship between growth, yield and yield components of maize (data not shown). The leaf area, number of green leaves, number of ear per plant, number of kernels per plant, thousand seed weight, dry biomass, were highly and significantly correlated with yield. The high correlation value indicated that the parameters have strong association with grain yield of maize due to high compost and N fertilizers application. Saleem *et al.*, (2007) reported that grain yield was significant and positive correlated with cob length, thousand seed weight, above ground dry biomass, number of rows per cob and number of grains per cob which is in agreement with this finding.

Conclusions

There are highly significance (P≤0.01) difference with the main effect of compost and nitrogen fertilizers to phenological (days to 50% tasseling, 50% silking, 90% maturity), growth (plant height, number of leaves per plant, leaf area index) and yield parameters (number of rows per cob, cob length, number of ear per plant). The interaction effects of compost and nitrogen fertilizer was significantly (P≤0.05) affected by LAI, number of kernels per ear, dry biomass,1000 seed weight, grain yield per hectare and harvest index of maize.

The result of correlation analysis showed that there was significance and positive correlation with most growth parameters, yield and yield components. Consequently, the outcomes of the present study indicated that higher grain yield (8298 kg/ha) was obtained from the application of 15t/ha compost plus 50% recommended N fertilizers rates when compared to all other treatments. Therefore, Combined use of fertilizers for maize variety Jibat was found to be agronomically superior at Toke Kutaye district.

Recommendations

1. To alleviate the full dependency on commercial fertilizer it is suggested that awareness creation

is required to shift the farmers' perception towards the combined use of both compost and nitrogen fertilizers as an alternative to enhance maize grain yield, improved fertility management and cost reduction.

2. The present study recommends/ suggest the application of compost 15 t/ ha plus 50% recommended nitrogen fertilizer interms of their economic benefits and production of optimum maize yields in Birbirsa and Dogoma area of Toke Kutaye district is recommended for maize production.

Reference

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