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Effect of Integrated Use of Organic and Inorganic Fertilizer on Soil Chemical Properties in Laelaymaichew, Central Zone of Tigray, Ethiopia

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Low soil fertility is the major constraint in crop productivity in Tigray region including Laelaymaichew woreda. Enhancement of crop productivity by application of inorganic fertilizer alone constrained by rising cost of chemical fertilizer calls for alternative fertilizer. Compost as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrient, but its shortage is a limiting factor. Integrated nutrient management, compost with chemical fertilizer could be the best approach to overcome the soil fertility problem in the area. This creates a need for understanding the interaction and combined effect of the natural and manmade sources of plant nutrients. A field experiment was conducted to determine the effect of combined use of organic and inorganic nutrient sources on soil chemical property. A 4x3 factorial experiment consisting of four levels of compost fertilizer (0 t/h, 4

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t/ha, 8t/ha, 12 t/ha) were combined with rates of chemical fertilizers (0, 50/50kg/ha and 100 /100kg/ha of Urea and DAP, respectively) was laid out in RCB design with three replications. Surface soil samples (0-30cm) before planting and after harvesting (composite sample) from each treatment were collected composite sampling and analyzed for soil P^H,EC,CEC ,OM, av.P and K and TN using standard laboratory The results revealed that soil Ph, Organic matter , CEC, av.P and Nitrogen contents of the soil increased with the use of compost which combines with chemical fertilizer ($p<0.05$).

Keywords: Compost; chemical fertilizer; integrated nutrient.

1. INTRODUCTION

Most soils in sub-Saharan Africa (SSA) have declining soil fertility, with low total nitrogen (N) and in many areas deficiencies in Phosphorus (P) [1,2] reported that low soil fertility is the bottlenecks to sustain agricultural productivity in Ethiopia. The logic behind here is that there is depletion of Organic Matter of the soil and decreasing of soil quality or health due to continuous conventional tillage to maintain food security.

Decline Soil fertility was also reported as a major constraint on crop production in the semi-arid highlands of Tigray, Northern Ethiopia [3]. Soil Organic matter depletion is a serious problem in Ethiopia due to excessive tillage, less returning animal dung and crop residues to soil i.e. dung used as fuel and crop residues used as feed [4]. Northern Ethiopia, the Tigray Region is characterized by land degradation and low rainfall. The degraded environment contributes to low agricultural production, exacerbating rural poverty [5]. The fertility of the soil has been decreasing due to continuous harvesting practices as a result of land fragmentation due to increased population pressure and depletion of organic matter due to widespread use of biomass as fuel, depleted macro and micro-nutrients, depletion of soil physical properties, and soil salinity which leads soil erosion and reduction in productivity [4].

Integrated soil fertility management combines organic and inorganic nutrients to achieve agricultural intensification to improve the livelihood of the farmers of today and the future while protecting the environment [6]. Composts along with inorganic fertilizers may sustain crop productivity and soil fertility [7]

Quality is critical to ensure long term soil fertility. Soil organic matter is a major source of plant nutrients and improves the physical properties of soil such as soil porosity, structure, and water holding capacity [8]. Compost as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients [9]

Chemical intensive strategy is ecologically and economically non-sustainable [6]. Intensive farming that relies solely on the use of agrochemicals leads to a gradual reduction of soil fertility. The application of mineral nitrogen, phosphorus and potassium, in a condition where there is low biological activity and low organic matter content in the soil eventually lead to a decline in productivity. Leaching according to Chandra [10].The use of chemical fertilizers (nitrogen, phosphorus and potassium: NPK) enhance crop yield, but brings alteration in soil properties, functional diversity in microbial populations and enzymatic activities. Moreover, continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate.

In addition to the adverse effect, the increasing price of inorganic fertilizer becomes the main factor limiting the use of inorganic fertilizer for the farmers. Replenishment of soil fertility with inorganic fertilizers at the recommended rate and appropriate time is constrained by high price of fertilizer that Inorganic fertilizer option remains unattainable to most of the smallholder farmers [11].

Therefore, integrated soil fertility management that maintains productivity, is economically feasible and ensures sustainable soil fertility (soil health) is the best approach to achieve sustainable agriculture. Therefore, this study was initiated to evaluate the integrated use of organic (compost) and inorganic (urea (N) with DAP (P) fertilizer on wheat yield and yield attributes, soil chemical properties, nitrogen and phosphorus uptake on wheat grains , evaluating the economic and social attributes in Laelay maichew woreda, central zone of Tigray.

Soil Organic matter depletion is a serious problem in Ethiopia due to excessive tillage, less returning animal dung and crop residues to soil i.e. dung used as fuel and crop residues used as feed [4].

Northern Ethiopia, the Tigray Region is characterized by land degradation and low rainfall. The degraded environment contributes to low agricultural production, in turn exacerbating rural poverty [5]. The study area L/machew woreda also experience the soil fertility depletion problem. Therefore the study evaluated the effect of combined and sole application of compost and Urea with DAP on soil chemical properties such as PH, EC, CEC, OM, Av P& K and TN in the study area.

2. MATERIALS AND METHODS

The study was conducted in the 2012 cropping season at Tabia Hatsebo, Lesaliso and Myweini which are found in the Laelay Maichew woreda area. The sites were chosen because wheat is one of the major cereals grown in the areas and farmers use both organic and inorganic fertilizers to improve soil fertility and increase productivity.

The field experiment was conducted in Tabiya Hatsebo Woreda Laelay Maichew of the central zone of Tigray. Laelay Maichew Woreda is found 245 km northwest of Mekelle around Axum (Fig. 1).

The experimental site (FTC of Tabia Hatsebo) location lies at latitude of 13^0 15' 00" and 14^0 39' 20" N, and 38^0 34' 00" and 39^0 25' 09" E longitude, and elevation of 2080 meter above sea level.

The area has good climatic conditions for growing wheat. The agro ecology of the area is tepid to cool sub-moist mid highlands or SM_2 5D-2 (weinadega) [12]. The elevation of the area ranges between 2050-2200masl. The mean annual temperature ranges from a minimum of 12^{o}C to an average annual maximum of 28^{o}c and the average annual rainfall is 500-900mm and rainfall starts in June and ends in September 13].

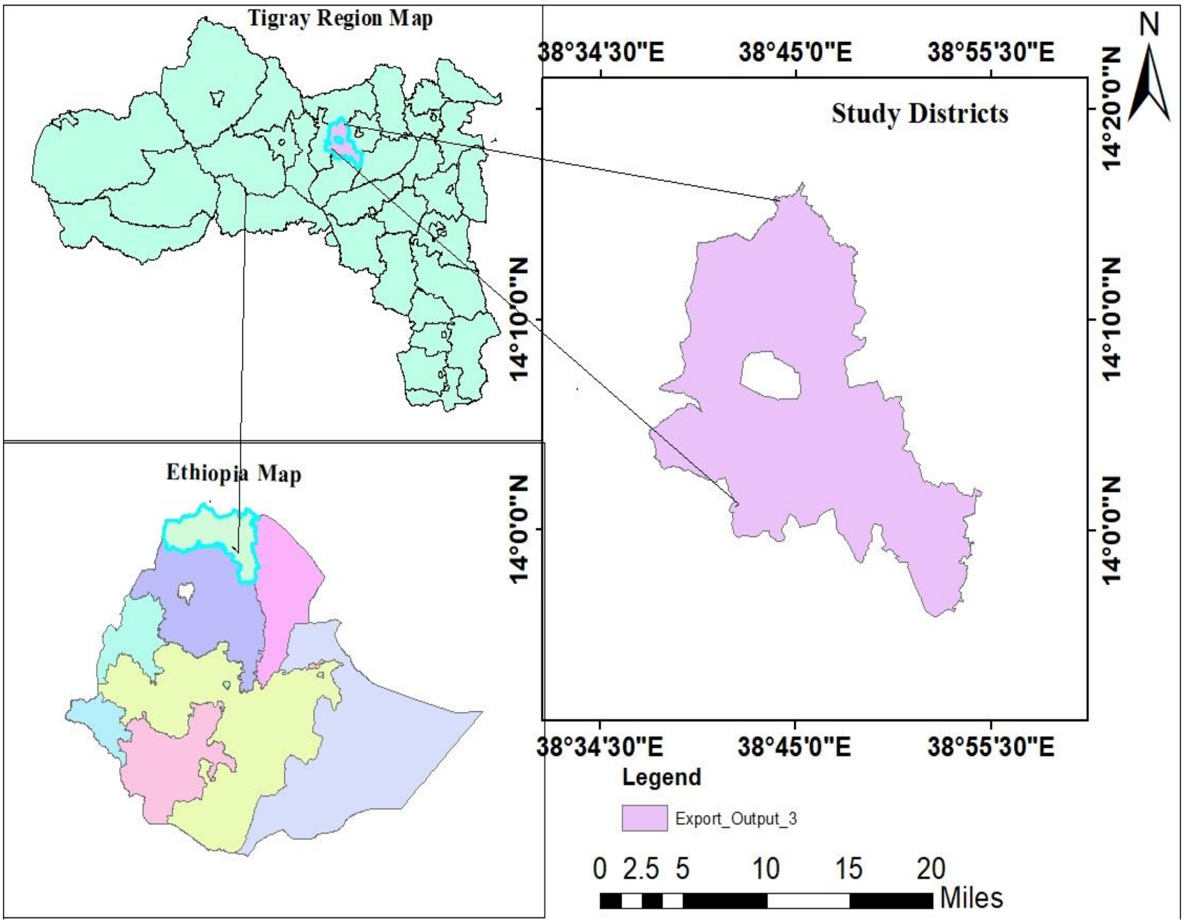

Fig. 1. Map showing study location

The five years monthly average minimum and maximum temperatures of the study area are presented in Appendix 1, Table 1 and that of rainfall in Table 2.

According to the pre-sowing soil analysis, the textural classification of the soil of the experimental site is clay soil while the common soil type of the Woreda is vertisol (38.4%), combisol (24.76%) and regosol (21.29%) and the remaining is other type of soil [13].

Laelay Maichew Woreda has various land use types that could be classified into arable land, irrigated land, grazing land, forest land and gully and mountain.The Woreda has a total area of 32833 hectare with 9533.57 ha arable land, 7720 ha forest land, 4405.5 ha grazing land and 8397.5 ha. Gully and mountainous land [13]. From the land under cultivation 6317.5 ha is rain fed land and 2639.85 ha is irrigated land.

Agriculture is the mainstay of the community. The economic activity of the study area is predominantly crop production and livestock production (mixed farming system).The crop production system of the study area is dependent on both rainfed and irrigation. Of the community members, 7466 male HH and 1369 female HH a total of 8835 households are irrigation users. The average landholding for households was 1.37 ha with minimum of 0.5 and maximum of 2.25ha.

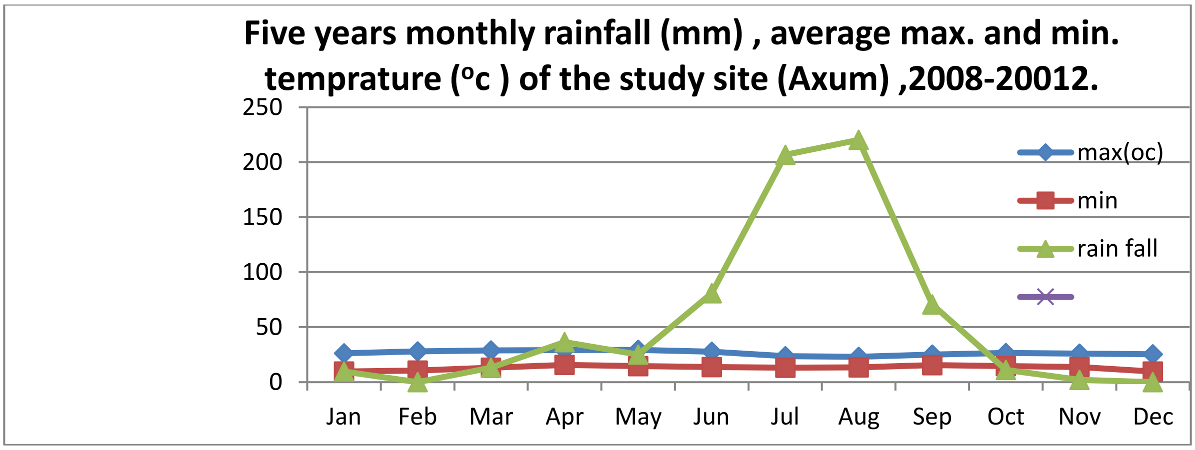

Fig. 2a.

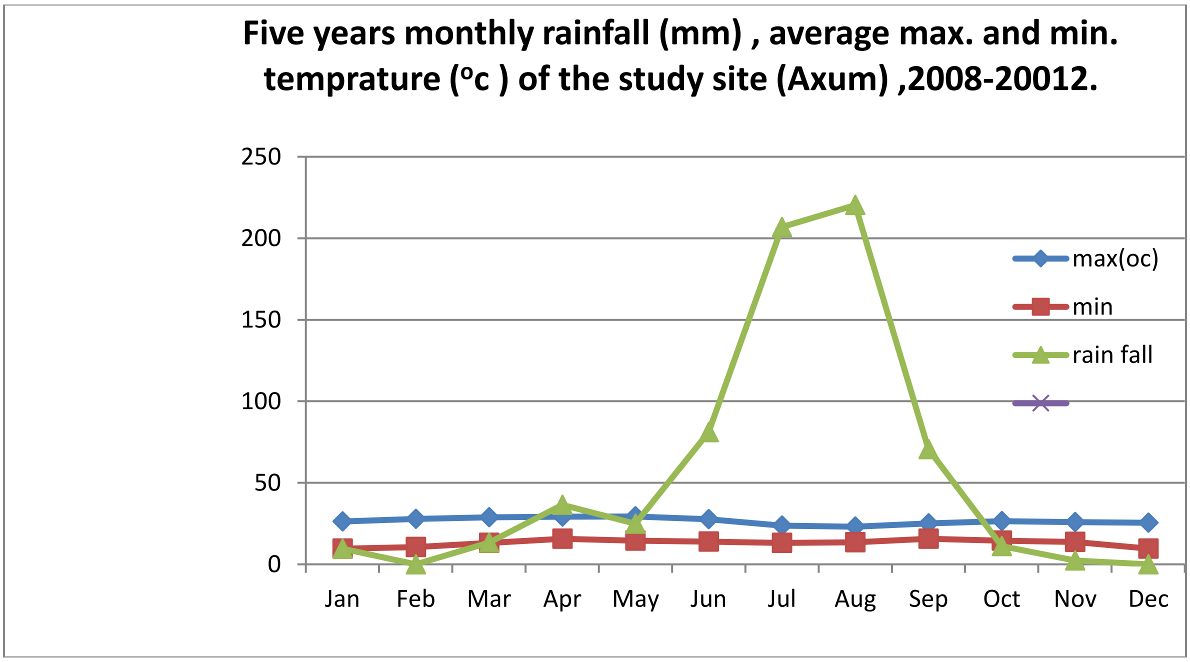

Fig. 2b.

Fig. 2. a-b. Five year's monthly rainfall (mm), monthly average max. and min. temperature (°c) of the experimental site, 2008-2012(Tigray Regional Meteorological Agency, Mekelle)

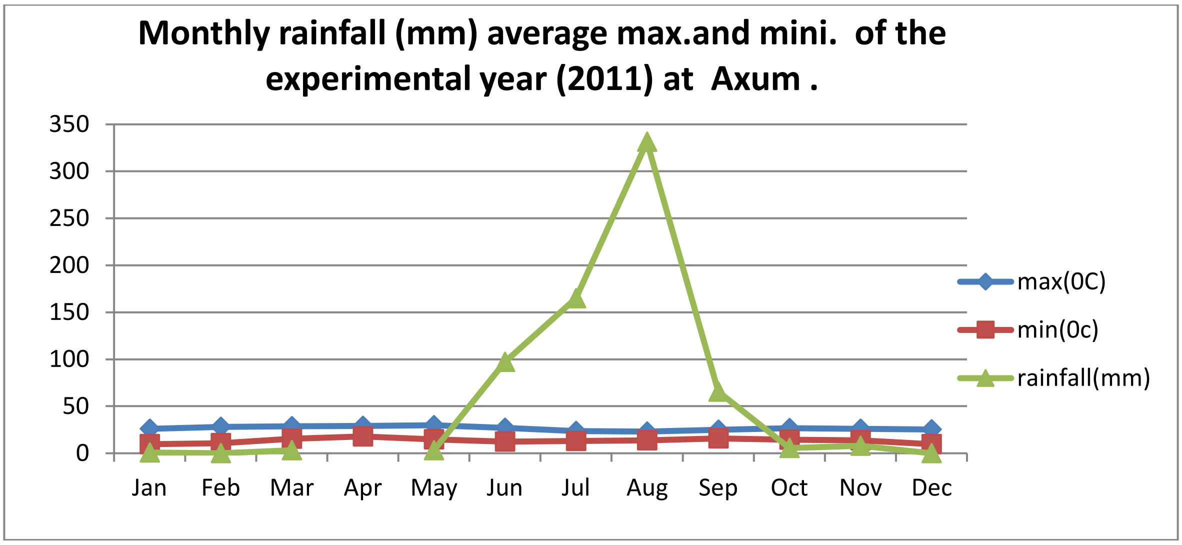

Fig. 3. Monthly average max., min. and average rainfalls (mm) of the experimental year, 2012

Table 1. Treatment combinations of compost and chemical fertilizer levels & rates used in the experiment

Trt	Compost(t/ha)	Chemical fertilizer (U+D or N&P)kg/ha	Treatment description
1	0	0	C control (no Com,no U+D(non fertilized)
2	0	50+50 or 32 & 23	0 Com, 50kg/ha U +50kg/ha D
3	0	100+100 or 64 & 46	0 Com, 100kg/ha. U +100kg/ha D
4	4	0	4t/ha Com, no U+D
5	4	50+50 or 32 & 23	4t/ha Com,50kg/ha U +50kg/ha D
6	4	100+100 or 64 & 46	4t/ha Com, 100kg/ha. U +100kg/ha D
7	8	0	8t/ha Com, no U+D
8	8	50+50 or 32 & 23	8t/ha Com,50kg/ha U +50kg/ha D
9	8	100+100 or 64 & 46	8t/ha Com, 100kg/ha. U +100kg/ha D
10	12	0	12t/ha Com, no U+D
11	12	50+50 or 32 & 23	12t/ha Com,50kg/ha U +50kg/ha D
12	12	100+100 or 64 & 46	12t/ha Com, 100kg/ha. U +100kg/ha D

Trt=treatment, Com=compost, CF=chemical fertilizer, U =Urea, D=DAP, N= Nitrogen, P = phosphorust-ton and ha=hectare

This study was carried out during the rainy season of 2011/12 at Laelay Maichew. The treatments consisted of a factorial combination of four levels of compost fertilizer and three levels of chemical fertilizer (Urea and DAP). The experimental design was RCBD in 4 x3 factorial arrangements with three replications and there were 36 plots. And the seed rate wheat (shina) was 120 kg/ha /1ha and 11gm/9m^2 Was used. A plot sizes of 3m x 3 m (9m^2) and total area of 564m^2 were used. The treatments were assigned randomly to each experimental unit within each block. The blocks were separated by1.5m, whereas plots within a block were 1m apart from each other and space between rows was 20 cm. The treatments were organic (compost) and chemical fertilizer (Urea plus DAP) as sources of plant nutrients with bread wheat (shina) as a test crop. The sources of the inorganic fertilizers contained DAP (Di-ammonium phosphate (18%N, 46%P) and Urea (46%N). A Full dose of DAP and half of the Urea were applied at the time of sowing and the remaining Urea was side dressed at the panicle initiation stage of the crop. The source of the compost was from the Hatsebo extension center. The compost was prepared at the Farmers Training Center (FTC) from grasses and weeds, crop residue, animal manure and other farm wastes and the materials were composted for two years. A Full dose of each rate of compost was applied during sowing time. There were three levels of the chemical fertilizer (CF) i.e. CF_1=0(control), CF2 =50kg/ha Urea (23kg N) +50kg/ha.DAP (9kg N & 23kg P) and

CF_3=100kg/ha. Urea (46 kg N) +100kg/ha DAP (18 kg N & 46kg P) and the levels of organic fertilizer (Compost) are com_1=0; Com_2=4t/ha, com_3 =8t/ha and Com_4=12t/ha.

2.1 Pre-Sowing and after Harvest Soil Sampling and Analysis

2.1.1 Soil sample collection

To analyze soil physical and chemical properties, a total of fifteen sub-samples were collected using an auger from the entire experimental field at 30 cm soil depth before planting. One composite soil sample was collected from each plot of the experiment in such a way that four from each corner the plot and one from the center of the plot so that one composite soil sample from each plot of the experiment was collected. After harvest, there were a totall 36 soil samples, five subsamples from each plot in each replication by making composite soil sample of 1kg for each plot were collected from the experimental field. Soil samples were analyzed at TARI(Tigray Agricultural Research Institute) Soils Laboratory center to determine the moisture and texture of soil before sowing and soil pH, total Nitrogen, available Phosphorus, CEC, EC, and Organic matter and available Potassium both before sowing and after harvest samples, but available K of soil after harvest were determined in Mekelle University. The physicochemical analysis collected soil sample soil was. First dried, next crushed and then passed through a 2mm mesh sieve.

To measure the moisture content of the soil fresh weight of the samples was taken immediately at the time of sampling. Then they were oven dried at 105°C for 24 hours and weighed to get the oven dry weight. The total moisture content of the soil was determined using gravimetric method which was calculated as the difference between the fresh weight of the soil sample and dry weight of that sample divided by the soil sample's dry weight on weight basis and the particle size distribution of soil was determined by hydrometer method.

2.2 Analysis of Soil and Compost chemical Properties

Soil samples collected both before and after harvest were analyzed for their chemical property. pH of soil and compost was measured in a suspension of a 1:2.5 soil to water ratio (pH meter) as described byJackson [14], Organic carbon (SOC) was determined by the method described byWalkeyand Black [15] and organic matter (SOM) soil and compost was then determined after multiplying SOC by a factor 1.724. CEC was determined by the ammonium acetate method [16]. Available soil and compost phosphorus were analyzed using the Olsen method [17]. To determine the available potassium in the soil and compost, the sample was extracted with Morgan solution and K in the extract was measured by flame photometer. Total N was determined using kejeldahl procedure [18] and EC was analyzed using EC Meter [19]

All soil parameters were subjected to analysis of variance (ANOVA) following a procedure appropriate to a factorial experiment in randomized complete block design as suggested by Ozume[20] and was computed using Gen-Stat 13th statistical software [21] Treatments that showed significant difference were subjected to DMRT (Duncan Multiple Range Test) for mean separation at 5% level of probability. Simple correlation analysis was also done to determine the Association of various agronomic (yield and yield components) and soil nutrient parameters.

3. RESULTS AND DISCUSSION

3.1 Physical and Chemical Properties of soil and compost before Sowing

Physical and chemical analyses of the soil were carried out for the surface composite soil (0-30cm) of the experimental field (Table 2).The total soil moisture content of the experimental site at sowing time was 30% on weight basis. The textural class of the surface soil was clay in texture with particle size distribution of 25% sand, 33% silt and 42% clay and the chemical characteristics of the soil; the pH was 7.7 (slightly alkaline), Av. P and TN content, 3.3PPM and 0.105%, respectively. According toFoth [22] available phosphorus of 3.3 ppm is (very low), organic matter content of 1.8% and total nitrogen of 0.10 % is low. According toBarber [23] and[24], CEC of 55.2 (meq/100g) is low, and organic carbon of 1.05% is deficient [25]. This result indicates that there is a need to apply external organic or inorganic nutrient sources to the field. The deficient organic carbon of soil could be due to removal of crop residue and low incorporation of biomass to the soil which might contribute to low organic matter and total nitrogen.

Table 2. Soil physical and chemical properties of the experimental site before sowing and chemical properties of compost in the experimental site Woreda Laelay Maichew woreda, 2012

Soil & compost characteristic	Texture				PH	O.C	O.M	CEC	Av.P	Av.K	TN	Ec
Characteristics	**Sand**	**Silt**	**Clay**	**Class**								
Unit	**%**	**%**	**%**			**%**	**%**	**Meq/100Kg**	**Ppm**	**Ppm**	**%**	**dsm^{-1}**
Content of soil	25	33	42	Clay	7.7	1.05	1.8	55.2	3.3	9.53	0.105	0.16
Content of compost					7.15	3.9	6.72	6.72	1.35	25.6	2.31	4.4

O.C=organic carbon, O.M=organic matter, Av. P= available phosphorus, Av. K= available potassium and TN=Total Nitrogen and EC= electrical conductivity.

The chemical composition of compost used in the experiment was characterized through laboratory analysis as presented in Table 2 was contained 3.9% organic carbon, 6.72% of organic matter (high), 2.31%N (very high), 1.35ppm available phosphorus (‘high’) and 25.0 ppm of available potassium [23] and [24].

3.2 Effect of Compost and Chemical Fertilizers on Soil Chemical Property

Soil pH is an important chemical property that affects the availability and mobility of soil nutrients and the activity of soil microorganisms. Low productive soils and sites are associated with low pH s and corresponding low levels of exchangeable bases and organic matter. The result of this study showed that soil pH was significantly affected both by the application of chemical fertilizer and compost alone ($p<0.001$) and their combination ($p<0.01$). In the treatments of compost alone, the highest pH value (7.77) was observed at the highest rate of compost used (12t/ha), while the lowest value (7.72) was observed from the zero compost. There is an increasing trend of soil pH for increased application of the different rates of compost but there was no significant difference for the application of 4t/ha of compost compared to the control (non-fertilized) as shown in Table3. Again about the effect of the sole application of chemical fertilizers, the highest soil pH of 7.75 was observed when 100kg/ha of chemical fertilizer was applied and the lowest was the control (pH=7.69). There was a significant difference between lower rates and higher rates but no significant difference was observed for the non-fertilized and 50 kg/ha rates of chemical fertilizers used.

3.3 Effect of Combined Application of Compost and Chemical Fertilizer on Soil Nutrients at Laelay Maichew Woreda, 2012

The effect of combined application of compost and inorganic fertilizer on soil $_P$H presented in Table 4 shows a significance difference ($p<0.01$). Application of the full rate compost and inorganic fertilizer at a higher rate (12 t/ha compost combined with 100 kg/ha of Urea and DAP increased soil $_P$H significantly over the control, application of the two sources alone and at the lower rate of compost and inorganic fertilizer in combinations (Table 4). As soil $_P$H, increased from 7.71 in the control to 7.8, when compost and Urea /Dap were applied at a rate of 12t/ha and 100kg/ha each Urea and DAP respectively. However, the application of combining the higher rate of compost with Urea & DAP was significantly different from the application of combining 12t/ha compost with 50/50kg/ha Urea & DAP(7.77 $_P$H). Comparing the $_P$H of the soil before and after harvest, soil $_P$H increased from 7.7 before sowing to 7.8 after harvest. The increase of soil $_P$H in both and alone application could be due to a hydrolysis reaction (as fertilizer is applied, nitrate is taken into the root plant and hydroxyl ion (OH-) is released into the soil) [26]. This result agree [27] that compost increasing effect on soil PH while disagreeing [28] that compost has a lower effect on soil PH.

EC of soil does not have a significant difference at $p<0.05$ for all levels of compost, chemical fertilizer applied alone and in combination of compost and chemical fertilizer (Table 3and 4).

The application of compost and chemical fertilizer alone significantly increased ($P<0.001$) the CEC of the soil. However, a non-significant difference was found for the combined application of compost with chemical fertilizers. Comparing the effect sole application of compost and chemical fertilizers on the CEC of the soil, the higher CEC (62.71) was when higher rate of compost was used (12t/ha) and the lowest CEC (59.11) was in the control as shown in Table 3 as indicated in the appendix. Application of chemical fertilizer alone, the lowest CEC was 59.69 from zero chemical fertilizer and the highest was 61.99 from application of 100kg/ha Urea and DAP and it was increased by 4.9%. Regarding the combined effect of compost and chemical fertilizer on soil CEC, no statistically significant differences, the highest CEC (63.63) of the soil was observed in treatment plots that received 12t/ha of compost with 100 kg/ha of chemical fertilizer and the lowest CEC (57.40) of the soil was observed from the treatment with neither of compost nor chemical fertilizer (control) and the differences was by 10.8% as presented in Table 4. Comparing the CEC of the soil before sowing and after harvest, it was increased from 55.2Meq/100kg to 63.63 Meq/100kg;this result is similar with the study of Ouedraogo *et al*. (2001) {38}, who reported that CEC was significantly different between 0 and 10 $t.ha^{-1}.yr^{-1}$. Contrary to Hailu (2010) {39}, reported CEC of the soil was not significantly different over the experimentation period and all the treatments, between 3.2t/ha and 6.4 t/ha compost application.

Table 3. Effect of compost and chemical fertilizer on soil nutrients at Laelay Maichew woreda, 2012

Variable	PH	EC(ds.m^{-1})	CEC(Meq/100kg)	TN (%)	OC (%)	av.P(ppm)	av.K(ppm
CF (kg/ha.)							
0	7.696a	0.1275a	59.69 a	0.1110a	1.323ab	3.178c	12.27c
50	7.742b	0.1250a	60.47a	0.1141b	1.209a	2.668b	10.74b
100	7.751 b	0.1225a	61.99b	0.1238c	1.363ab	2.205a	9.38a
SEM(±)	0.00744	0.00240	0.362	0.0008	0.017	0.1432	0.0828
LSD(0.05)	0.02183	0.00703	1.062	0.0022	0.050	0.4200	0.2428
Compost(t/ha)							
0	7.721b	0.1244a	59.11 a	0.1006a	1.099a	2.276a	9.63a
4	7.739b	0.1244a	59.79a	0.1144b	1.187b	2.200a	10.27b
8	7.690a	0.1256a	61.26b	0.1226c	1.410c	2.589a	11.66c
12	7.768c	0.1256a	62.71c	0.1274d	1.499d	3.671b	11.63c
SEM(±)	0.00860	0.00277	0.418	0.0009	0.015	0.1653	0.0956
LSD(0.05)	0.02521	0.00812	1.227	0.0026	0.043	0.4849	0.2804

Means within the same column followed by the same letter do not differ significantly at the 5% level of significance; CF=Chemical fertilizer; OM= organic Matter; TN= total nitrogen; SEM= standard error of the mean; CEC= cation exchange and EC=Electrical conductivity

Table 4. Effect of combined application of compost and chemical fertilizer on soil nutrients at woreda Laelay maichew ,2012

Treatments	Treatment combinations		PH	EC	CEC	TN	OC	av.P	av.K
	Compost (t/ha.)	CF (kg/ha.)							
Trt1	0	0	7.71bcde	0.1233a	57.40a	0.0910a	1.077a	1.74abc	13.60f
Trt2	0	50/50	7.70bc	0.1300a	59.53abc	0.1049b	1.097 ab	3.613f	11.40d
Trt3	0	100/100	7.75def	0.1200a	60.40 bcd	0.1058bc	1.123 ab	1.473a	3.90a
Trt4	4	0	7.71bcd	0.1233a	58.43ab	0.1257e	1.169abc	2.50cde	11.53d
Trt5	4	50/50	7.75def	0.1233a	59.93bc	0.1161 d	1.172 bc	2.613cde	9.60b
Trt6	4	100/100	7.76efg	0.1267a	61.00 cde	0.1262ef	1.220cd	1.487ab	9.67b
Trt7	8	0	7.63a	0.1333a	60.21bc	0.1101c	1.466e	2.893def	12.23e
Trt8	8	50/50	7.75cdef	0.1233a	60.63bcde	0.1047b	1.270d	2.047abcd	10.50c
Trt9	8	100/100	7.69b	0.12a	62.93ef	0.1283ef	1.494e	2.827def	12.24e
Trt10	12	0	7.73bcdef	0.1343a	62.73def	0.1170 d	1.582 f	5.580g	11.73d
Trt11	12	50/50	7.77fg	0.1233a	61.77cdef	0.1307fg	1.298d	2.400acde	11.47d
Trt12	12	100/100	7.80g	0.1233a	63.63 f	0.1347g	1.617f	3.033ef	11.70d
SEM(±)			0.01489	0.00479	0.724	0.0015	0.030	0.2864	0.1656
LSD(0.05)			0.04366	0.01406	2.124	0.0045	0.087	0.8399	0.4857
CV (%)			0.3	6.6	2.1	2.3	3.9	18.5	2.7

Means within the same column followed by the same letter do not differ significantly at the 5% level of significance; CF=Chemical fertilizer; OM= organic Matter; TN= total nitrogen; SEM= standard error of the mean; LSD = Least significance difference; CEC= cation exchange and EC=Electrical conductivity

Table 5. Correlation matrix of major soil parameters

	PH	EC	CEC	TN	OM	av.P	av.K
PH	1	-0.2127^{ns}	0.3204^{ns}	0.3383*	-0.0509^{ns}	-0.1403^{ns}	-0.2957^{ns}
EC		1	0.0746^{ns}	-0.0697^{ns}	0.1621^{ns}	0.2960	0.2010^{ns}
CEC			1	-0.0697^{ns}	0.1621^{ns}	0.2960^{ns}	0.2010^{ns}
TN				1	0.5321**	0.1470^{ns}	0.0796^{ns}
OM					1	0.5448**	0.2154^{ns}
av.P						1	0.3341*
av.K							1

** & ** indicate significant at 5% and 1% probability level, respectively; ns= non-significant*

The application of compost alone and combining compost with chemical fertilizer had a significant effect on the Organic carbon content of the top soil (0-30) ($p<0.001$) but no significant effect ($p>0.05$) when chemical fertilizer was applied alone. In the application of compost alone, the highest organic carbon content (1.499) was from the application of 12t/ha compost, while the lowest (1.099) was from the application of zero compost (Table 3).The organic carbon was significantly increased as the rate of application of compost was increased from 0-12t/ha which could be due to the application of organic compost. In the results of combined application of compost and chemical fertilizer, the organic carbon at harvest showed significant variations among the treatments. The highest OC% (1.617) was from the combined of 12 t/ha and 100kg/ha chemical fertilizer and the lowest OC% (1.077) was from the treatment with neither compost nor chemical fertilizer (Table 4). There was a higher improvement of OC % in all the treatments that received the highest level of compost when combined with all levels of chemical fertilizer. The organic carbon content of the experimental soil was improved from 1.05% to 1.617% compared to before sowing and at harvest of the soil. This result disagrees with the study by Ouédraogo et al. [29] that there was no significant difference in a short-term effect in soil organic content between the 5 and 10 t/ha compost application and the non-composted. However, the study conducted in Egypt byWahba [30] reported a significant change of organic carbon at 20 t/ha compost application supports the current study and study conducted byAzarmi[31]the significant organic carbon content and NPK increase within three months was found to be in the 15 t.ha-1.yr-1 application.

The results of the mean squares analysis of the effects of organic and inorganic fertilizers on total nitrogen. The ANOVA for Total Nitrogen showed that the N content of the soil after harvest was significantly increased following the application of both fertilizer types and all rates of fertilizers (Table 3 and4). The total N content of the soil increased as the level of compost and chemical fertilizers were applied. Compost alone applied at its highest rate (12t/ha) improved N-content by 40% (0.1274) relative to the control or non-fertilized (0.10). The chemical fertilizer at its rate (100kg/ha) gave 0.1238 total N-content and it was increased by 35.2% and the lowest was the control (0.111). The rate of N- content improvement of compost was higher than the chemical fertilizer. This result could be due to the low mineralization of organic nitrogen to be taken by the plant. From the combined application, the full rate of compost and chemical fertilizer, gave the highest total content (0.1347), which is an increase of 48% from the control(0.0910) and 28% & 27% than the half rate (50/50kg/ha.) and full rate (100/100kg/ha.) of chemical fertilizers respectively, when applied alone (Table 4). Hence, combined application of both types was found superior to obtaining higher application alone either of the fertilizer types. This result could be due to the high amount of nitrogen application from both compost and chemical fertilizer sources. The N-content of soil was increased from the before sowing (0.105) to at harvesting (0.1347). this result agrees withHailu [32] where significantly higher total soil N was from the application of6.4 t.ha-1-yr-1 of compost and mineral fertilizer than the control at the end of the experimentation period.

Both the main factors (compost and chemical fertilizer) and their combined effects significantly influence the content of the available phosphorous after harvest. Concerning the main effects of the chemical fertilizers (Table 3), the available phosphorous content of the soil showed a general decreasing trend with an increased rate of chemical fertilizers. The Highest and the most significant increase of available phosphorous was recorded with zero chemical fertilizer (3.178ppm) than the higher rates 100kg/ha (2.205 ppm) which an 86.5% increase from the control. As the application rate of the compost fertilizer increased from zero to 12 t/ha, the available P also increased significantly from 2.276ppm to 3.67ppm and increased by 115.9% from the control treatment (Table 3). The mixture of compost with chemical fertilizers (DAP and Urea) also increased significantly soil on available P (Table 4). The highest value of available P of 5.580 ppm was found when 12 t/ha of compost was applied alone (without chemical fertilizer, followed by mixture of 12t/ha of compost and 100kg/ha chemical fertilizer (3.033ppm) as shown in Table 4. The results could be due to the uptake of phosphorus by the crop and re an indication that addition of compost had added higher amounts of P to the soils. The improvement in available P of the soil might be accounted for by organic sources that might have favored the release of higher amount of available P from the soil. The Increase of available phosphorus might be due to the decomposition of organic matter accompanied by the release of appreciable quantities of carbon-di-oxide, as carbon-di-oxide production plays an important role in increasing phosphate availability [33]. This result agrees with the findings ofHailu [32] where there is a significant increase in the phosphorus of the plots applied with mineral fertilizer and 6.4 t/ha compost as compared to the control and 3.2 t/ha compost application.

Available potassium (K) of soil is also influenced by the application of compost and chemical fertilizer and their combination. In application compost the lowest available K (9.63 ppm) was from the zero compost rates (control) while the highest available K (11.66 ppm) was from the 8t/ha compost rate but a slight decrease was observed in 12t/ha as shown in Table 3. In chemical fertilizer as main effect the highest available potassium K (12.27ppm) of soil was from the rate of zero Urea and DAP while lowest was from the higher rate (100kg/ha. And there is a significant decreasing trend as go from the zero chemical fertilizer (12.27ppm) to the higher rate (9.38ppm). In the integrated effect of compost and chemical fertilizer the highest available potassium K (13.60ppm) from the control while the lowest was from the treatment received zero compost and 100kg/ha chemical fertilizer. As shown in Table 4 decreasing of potassium significantly in the soil, after application of both types and all rates of fertilizer, except in chemical fertilizer applied alone at full rate(100/100kg/ha. This result could be due to no application of K as fertilizer in experiment treatment except the K sourced from the content of compost. The study result was similar toTayebeh et al. [34] reported that potassium in soil increased in the higher compost applications i.e.70 and 105 t.ha-1yr-1. The study of Laelay[35] that highest available K contents from the 45 and 134 t.ha-1yr-1 compost applications were achieved [36].

3.4 Correlation Matrix of Major Soil Parameters

The results of estimates of correlation coefficients between each pair of the characters studied are presented in Table 5. Results on simple correlation coefficients revealed that the soil fertility after harvest exhibited significant ($p<0.001$) positive correlation with the major soil quality characters such as available P, available K, organic matter, soil PH and total nitrogen etc. Available P was positively correlated with available K ($r= 0.3341^*$ $p<0.05$) indicating that available P increased as av. K increased and soil pH was significantly correlated with soil total nitrogen ($r=0.34^*$ $p<0.05$). Organic matter was also positively correlated with total nitrogen($r=0.5321^{**}$) and available P ($r=0.5448^{**}$) but not significant correlation was obtained between EC($r=0.1621^{ns}$), CEC($r=0.1621^{ns}$) and available k($r=0.2154^{ns}$) as is indicated in Table 5. [37,38].

5. CONCLUSION

From the study it was able to conclude that effects of combined application of compost with chemical fertilizer showed significant effect in soil chemical properties. The statistical analysis result showed major soil chemical property the experimental site such as Soil pH, organic carbon, CEC, available P and K and total nitrogen increased significantly as the rate of application of compost alone and in combination rates increased.

The result of both soil analysis parameters indicated the soil fertility of the site was very low. Combined use of compost with chemical fertilizers showed better improvement in soil chemical properties than compost alone application or chemical fertilizer.

Correlation of major soil parameters like organic matter, total nitrogen, available P and K showed positive and significant correlation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models

(ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Pali PN, Delve2 R, Nkonya E. Using linear programming to optimize the use of biomass transfer and improved fallow species in eastern Uganda.African Crop Science Conference Proceedings, African Crop Science Society. 2003;6.
2. Wakene N, Fite G, Abdena D, Berihu D.integrated use of organic and inorganic fertilizers for maize production; 2007.
3. Marc C, Abebe S, Mitiku H. Farmers' knowledge of Soil fertility and local Management strategies in Tigray, Ethiopia. Managing Africa's soil. 2000;10.
4. Zelleke G, Getachew A, Dejene A, Shahidur R fertilizer and Soil Fertility Potential in Ethiopia; 2010.
5. Sue Ed, Tewolde Berhan G, Hailu A. Successes and challenges in ecological agriculture: experiences from Tigray, Ethiopia. 2010.
6. Askel Naerstand (editor). Can Africa Feed Itself. The organizing committee of the conference Oslo, Norway; 2007.
7. Muhammad A, Asif Naeem, Javed A, Syed A, Wajid I. Improvement in nutrient uptake and yield of wheat by combined use of urea and compost; 2011.
8. Gamal A, Rahman). Impact of compost on soil properties and crop productivity in the Sahel North Burkinafaso. Desert Research centers atarya, Egypt; 2009.
9. Tayebeh A, Abass A, Seyed AEffect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat. AJCS. 2010;4(6):384-389.
ISSN: 1835-2707.
10. Chandra SNMicrobes for Soil Sustainability and Crop Productivity. International society of Environmental botanist. 2012;18:3.
11. Linda L, Robert. Adoption of soil fertility improvement technologies among smallholder farmers in southern malawi. Master thesis 30 credits; 2006.
12. AxARC (Wheat variety introduction and adaptation trials in L/maichew, central zone of Tigray; 2012.
13. Laelay Maichew Bureau of Agriculture and Rural Development. General description of Woreda Laelay Maichew; 2012.
14. Jackson ML.Soil chemical analyses. Prentice-Halls Inc., Madison, Wisconsin, US.; 1958.
15. Walkey A, Black IA. An experimentation of the digestion method for determination; 1934.
16. Okalebo JR, Guathua K.W., Woomer PL Soil laboratory Methods and PlantAnalysis.Working Manual, Karhsobf, Nairobi, Kenya. 1993;55.
17. Olsen SR, VCole, FS, Watenable LA Dean Estimation of available phosphorus in soils

by extraction with sodium bicarbonate. USDA Cir. 1954;939.
18. Dawis and Frietas Physical and Chemical methods of soil analysis. FAO Bulletin; 1970.
19. Sahelemedhin Sertsu and Taye Bekele. Procedures for Soil and Plant Analysis.Technical paper #74. National Soil Research Center, Ethiopia Agricultural Research Organization, Addis Ababa, Ethiopia; 2000.
20. Ozume G. Stastical procedures for A.gricutural analysis; 1984.
21. Gen-Stat Gen-Stat for Windows (12th Edition) Introduction. VSN International; 2009.
22. Foth HD. Fundamentals of Soil Science, 8th edition, John Wiley and Sons. Inc. 1991;360.
23. Barber R. An assessment of the dominant soil degradation processes in the Ethiopian highlands; their impacts and hazards. 2010; 23, LUPRD, MoA and FAO; 1994.
24. London. Effect of organic and inorganic fertilizer on chemical property of soil; 1991.
25. Defoer T, Budelman A, Toulmin, Carter S.E. Managing Soil Fertility in the Tropics, Amestardem, The Netherlands; 2000.
26. Camberato JJ. Nitrogen in soil and fertilizers. 2001;8(1):6-10.
27. Bevacqua RF, Mellano VJ. Cumulative effects of sludge compost on crop yield and soil properties. Communications in Soil Science and Plant Analysis. 1994; 24:395-406.
28. Crecchio C, Curci M, Mininni R, Riccuti P, Ruggiero P. Short-term effects of municipal solid waste compost amendments on soil carbon and nitrogen content, some enz yme activities and genetic diversity. Biology and Fertility of Soils. 2001;34:311-318.
29. Ouédraogo E, Mando A, Zombré NP. Use of compost to improve soil propertiesand crop productivity under low input agricultural system in West Africa. Agriculture,Ecosystems and Environment. 2001;84:259-266.
30. Wahba MM. Influence of compost on morphological and chemical properties of sandysoils, Egypt. Journal of Applied Sciences Research. 2007;3(11):1490-1493.
31. Azarmi R, Giglou MT, Taleshmikail RD. Influence of vermicompost on soil chemical and physical properties in tomato (*Lycopersicum esculentum*) field. African Journal of Biotechnology. 2008;7(14): 2397-2401.
32. Hailu. The effect of compost on soil fertility Enhancement and yield increment under smallholder farming, The case of Tahtai-Maichew district – Tigray region, Ethiopia, University of Hohenheim, Germany, PhD Thesis. 2010;186.
33. Smiciklas KD, Walker PM, Kelley TR. Evaluation of compost for use as a soilamendment in corn and soybean production. Compost Science and Utilization. 2008;16(3):183-191.
34. Tayebeh A, Abass A, Seyed A. Effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat. 2010;4(6):384-389.
ISSN: 1835-2707.School of
35. Laelay Maichew Bureau of Agriculture and Rural Development. General description of Woreda Laelay Maichew; 2012.
36. Foth HD. Fundamentals of Soil Science, 8th edition, John Wiley and Sons. 1991;360.
37. Ouédraogo E, Mando A, Zombré NP. Use of compost to improve soil propertiesand crop productivity under low input agricultural system in West Africa. Agriculture, Ecosystems and Environment Agriculture, Shiraz University, Shiraz, Iran. 2001;84.
38. Okalebo JR, Guathua KW, Woomer PL. Soil laboratory Methods and PlantAnalysis.Working Manual, Karhsobf, Nairobi, Kenya. 2010;55.

APPENDIX 1

Table A1.1 five years monthly average min and max temperature of the study area ,2008-2012

	2008		2009		2010		2010		2012	
	Max	**Min**	**Max**	**Mini**	**Max**	**Min**	**max**	**Min**	**Max**	**min**
Jan	26.3	10.8	26.6	9.1	26.3	9.7	26.2	9	26	9.8
Feb	27.1	10.6	28.3	11.9	28	11.3	27.9	8.8	28.1	10.7
Mar	29.1	12.5	29.6	12.8	28.3	13	28.1	12.4	28.8	15.3
Apr	27.9	15.8	30	14.4	29.6	15.3	29.7	14.9	29.1	17.9
May	28.7	14.3	30.2	15.3	29.8	15.1	28.2	13.6	29.8	14.575
Jun	26.5	13.3	29.5	15.1	28.4	14.5	27.3	13.7	26.9	12.5
Jul	23.8	12.9	24	13.5	23.1	13.3	23.7	13	21.6	13.175
Aug	23.2	13.6	24	13.5	22.9	13.9	22.2	13.3	21.9	13.575
Sep	25.2	12.2	26.3	26.7	25.1	11.4	23.6	12.2	23.2	15.625
Oct	26.6	10.6	26.8	26.3	26.7	10.6	25.9	10.7	25.5	14.55
Nov	25.6	10	26.8	25	26.3	9.8	25.2	10.3	25.4	13.775
Dec	25.6	9.3	26.2	9.7	25.6	8.2	24.3	11.5	25.3	9.675
Average	26.3	12.15833	27.35833	16.10833	26.675	12.175	26.025	11.95	28.11667	13.43

Source; Tigray Regional Metrological Agency , Mekelle

Table A2. 2five years monthly annual rainfall of the study, 2008-2012

	rain fall				
	2008.0	**2009.0**	**2010.0**	**2011.0**	**2012.0**
Jan	37.6	0	10	0	0.8
Feb	0	0	0	0	0
Mar	0.4	6.7	50.8	5.2	3.2
Apr	56.3	0.9	52.1		0
May	38.3	22.5	10.1	50.6	3.3
Jun	80.3	60	111.6	55.9	97.2
Jul	169.3	196.3	280.2	223.7	165
Aug	186.9	214.7	202.8	166	331.3
Sep	56.2	11.2	148.5	71.7	65.4
Oct	1.5	0	37.8	x	5.6
Nov	3.4	0	0	0	8
Dec	0	0	0	0	0
total	630.2	512.3	903.9	573.1	679.8

X is data missing for 2011; Source; Tigray Regional Metrological Agency, Mekelle

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