Int.J.Curr.Res.Aca.Rev.2022; 10(06): 101-110

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 10 Number 06 (June-2022)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2022.1006.009

Enhancing the Productivity of Salt-affected Soil through Application of Integrated Organic and Inorganic Fertilizers: The Case of Middle Awash Valley, Ethiopia

Diriba Megersa Soboka[1*], Mekuria Bekele[2] and Bethel Nekir[3]

[1]Ambo Agricultural Research Center, Ambo, Ethiopia.
[2]Werer Agricultural Research Center, Ethiopian Institute of Agricultural Research, EIAR P.O.Box -2003, Werer, Ethiopia
[3]Welkite Agricultural Research Center, Ethiopian Institute of Agricultural Research [EIAR] P.O.Box-2003, Welkite, Ethiopia

*Corresponding author

Abstract

Though Maize is a staple food crop in Ethiopia, its productivity in Salt affected area is not satisfactory due to the existing soil fertility degradation. The experiments were conducted during 2016 -2018 in Middle Awash Walley areas to evaluate the integrated applications of compost with different levels of nitrogen fertilizer rates and its economic feasibility on maize production. Randomized complete block design was employed with three replications involving 4 levels of nitrogen from compost (23, 46, 69, 92 kg ha^{-1}) and 4 levels of inorganic nitrogen (23, 46, 69, 92 kg ha^{-1}) from urea fertilizers in factorial combination. Compost was prepared following the standard procedure for compost preparation and applied in N-equivalent based. Pre-planting and after planting soil sample was collected at 0-30 cm soil depth and analyzed following the standard procedures. Biomass and grain yield were subjected to analysis of variances using SAS software program. Partial budget analysis technique was applied on the yield results. Analysis of variance showed a significant difference for all parameters (plant height, biomass and grain yield of maize) due to the main factor of treatments applied. Higher grain yields were recorded across the treatments due to the integrated application of compost and inorganic fertilizer. The combined application of 46-kg ha^{-1} N from Urea and 23-Kg ha^{-1} N from compost is economically acceptable and can be considered as alternative recommendation for the area to enable sustainable production and soil health improvement.

Article Info

Received: 03 May 2022
Accepted: 28 May 2022
Available Online: 20 June 2022

Keywords

Economic feasibility, inorganic fertilizer, integrated application, maize, middle awash, Organic.

Introduction

Maize is one of the principal crops and staple food in Ethiopia (Ofcansky and Berry, 1991; Abate *et al.*, 2015) even though its productivity has been affected by different factors such as soil fertility depletion. Hence, in Salt affected areas of the Country food crop production is challenged by miss management of nutrients and irrigation water (Figure 1 below) and one of the bottlenecks to sustain agricultural production and productivity. Reclamation of Such Salt affected soil is a very labor intensive and need huge investments. The effort by Werer Agricultural Research Natural Resource Research Department and International Center for Biosaline (ICBA) project in reclaiming the productivity of Salt affected soil of Amibara areas, Afar region Ethiopia, is an appreciable works (figure 2 below).

Different management options were applied to this Salt affected soil. Here, Chemical amendment was one of those management option though its economical feasibility become enormous speculation. Salt tolerant forage grasses species (*Cinchrus ciliaris and Chloris gayana*) were among best farming practices to reutilize the marginal environment (Worku *et al.*, 2019).

Photos from Werer Agricultural Research Center, Natural Resource Research Department

In addition to these explained efforts, integrated nutrient management is one of the alternatives of reducing serious soil fertility degradation as it utilizes available organic and inorganic nutrients to build ecologically sound and economically viable farming system. Intensive cultivation, continues and mono growing of cotton, use of unbalanced and inadequate fertilizers accompanied by restricted use of organic manures have made the soils not only deficient in the nutrients, but also deteriorated the soil health resulting in declining crop response to recommended dose of NP fertilizer in the region (Getinet *et al.*, 2016). Under such situation, integrated plant nutrient system has a great importance and vital significance for the maintenance of soil productivity (Kimetu *et al.*, 2004; Getachew and Taye, 2005). Organic manures, like compost and vermi-compost are not only supply macronutrients but also meet the requirements of micronutrients, besides improving soil health.

According to Getachew *et al.*, (2012), the application of half the recommended rate of NP fertilizer with 50% of the recommended dose of compost (3 t ha^{-1}) can be an alternative best integrated soil fertility management approach instead of applying sole inorganic fertilizers for sustainability. Getinet and Wassie (2019), have also suggested that combination of 69 kg ha^{-1} N from mineral fertilizer and 5.6 ton ha^{-1} compost as the best combination to achieve sustainable yield.

Additionally, Getinet *et al.*, (2016) have also forwarded integrated use of compost as good option for developing effective plant-nutrient management strategies and sustaining the crop production on small-scale farming. However, applications of sole compost, animal manure or crop residue are challenged in providing enough yields in short-term effect due to its slow release of nutrients. Consequently, these experiments were designed to evaluate the combined applications of compost with different levels of nitrogen fertilizer rates and its economic feasibility on maize production.

Materials and Methods

Descriptions of the study areas

The experiments were conducted on one farmer's field (Serweba kebele) Fentale Woreda, Oromia region; and at Werer Agricultural Research Center on-station Hali Deba kebele, Amibara Woreda, Afar region Ethiopia during 2017 - 2019 off-cropping seasons.

The study areas are geographically located between 8^{o}49'0" N and 9^{o}44'0" N latitude; and 39^{o}40'0" E and 40^{o}20'0" E longitude (Figure 1.) with an altitude of 740 m.a.s.l. The average annual rainfall of the area is 593 mm, and the average maximum and minimum temperatures of the study areas are 34^{o}C and 19^{o}C, respectively. The dominant soil type is Fluvisols that had been deposited by alluvial deposition.

Experimental design and treatments setup

Factorial randomized complete block design was laid-out with three replications involving four combinations of different levels of Nitrogen from compost (23, 46, 69, 92 kg ha^{-1}) with another 4 different levels of inorganic Nitrogen (23, 46, 69, 92 kg ha^{-1}) from urea fertilizers (Table 2). Additionally, 20 kg ha^{-1} of recommended phosphorus fertilizer was applied to all treatments during planting. Compost was prepared (Figure 2) following the standard procedure for compost preparation (Getachew *et al.*, 2012).

Nitrogen content of the compost was analyzed at Debrezeit Research Center laboratory in order to determine amount of compost to be applied in the basis of N-equivalent of the recommended nitrogen. The compost nitrogen and moisture content are summarized in table 1 below. Melkassa-$_2$ maize variety was used as a test crop with all recommended agronomic practices.

According to table 1 above, 23 kg N ha^{-1} from compost represents 4.305 t ha^{-1} compost, 46 kg N ha^{-1} from compost, represents 8.61 t ha^{-1} compost and others likely. Consequently, the above result of compost in N-equivalent should be considered in such way.

Data collection and analysis

Soil samples collection and analysis

A composited soil sample was collected from the experimental site in each study location before planting and for each treatment after harvest at 0-30 cm soil depth. The chemical compositions of the soil samples were analyzed at the Soil Laboratory of Werer Agricultural Research Center following standard procedure. Soil paste extract of ECe and pHe was measured potentiometrically using a digital electrical-conductivity and pH-meter, respectively (Richards, 1954). Organic matter was determined following Walkley and Black wet-oxidation method (Walkley and Black, 1934) and the total N by Kjeldahl procedure (Bremner, 1996). Available phosphorous was determined following the Olsen method (Olsen *et al.*, 1954) after extraction with sodium bicarbonate solution (pH 8.5).

According to the soil textural class determination triangle, soil of the experimental site is silty clay loam and loam for WARC and Fentale site (Table 3). The soil pH of the experimental sites was alkaline and moderately alkaline for WARC and Fentale, respectively. The soil organic matter range was low for both locations.

Crop yield data collection and analysis

Yield parameters: biomass and grain yields were collected, weighed (gram/plot) and converted to kilogram per hectare for statistical analysis. Grain yield was adjusted to a moisture content of 12.5% before statistical analysis and subjected to analysis of variances using SAS software program version 9.0 (SAS Institute, 2003). Significant differences between treatment means was compared and separated using the least significant difference (LSD) test at 0.05 probability levels (Gomez and Gomez, 1984).

Economic Analysis

Partial budget analysis technique as described by CIMMYT (1988) was applied on the yield results. The analysis was done using the prevailing market prices for inputs at planting and for outputs at the time of crop harvest. All costs and benefits were calculated on hectare basis in Ethiopian Birr (Birr/ha). For a treatment to be considered as worthwhile option to farmers, the minimum acceptable rate of return (MRR) should be 100% (CIMMYT, 1988), which is suggested to be realistic.

Results and Discussion

Soil results

Post-harvest soil result showed that applied fertilizer and compost showed no notable trend of increasing or decreasing order on soil pH. Hence, the highest pH was recorded from control, whereas the lowest was from 92-Nitrogen from Urea fertilizer + 69-N from compost (Table 4). The available potassium (K) at Werer Agricultural Research Center (WARC) was ranged between 1.47 to 9.86 ppm and 0.22 to 2.34 ppm at Fentale site. In terms of available P, the highest available P was recorded from 69-N from Urea fertilizer + 46-N from compost, while the lowest was recorded at 46-Nitrogen from Urea fertilizer + 0-N from compost at WARC site. Soil organic matter did not showed linearly increasing or decreasing trend with the application of urea and compost fertilizer.

Plant height, biomass and grain yield results

The crop field performance was impressive (figure 5 below) that the analysis of variance for combined data over years and locations of the parameters recorded were indicated in Table 5. As shown in the table, high significant difference were observed for all parameters recorded (plant height, biomass and grain yield of maize) due to the main factor of treatments applied. Likewise, the year and location main effects were also significant on biomass yield of maize (Table 5). Better biomass yields were recorded during 2017 and 2018 at Werer experimental site; whereas, nearly similar grain yields were recorded across years and locations. However, neither two-way nor the three-way interaction (Table 5) of year by location by treatment were-significant for all the parameters

Plant height was significantly influenced by treatments (Table 6). Here, the significantly highest mean plant heights (237.84, 239.18 and 235.43 cm) were recorded at the treatment combinations of 92 kg ha^{-1} N from Urea + 46 kg ha^{-1} N from compost, 92 kg ha^{-1} N from Urea + 69 kg ha^{-1} N from and 69 kg ha^{-1} N from Urea + 69 kg ha^{-1}N from compost respectively. This might be due to the huge application of nitrogen both from compost and urea fertilizer.

In terms of biomass yields, the highest biomass yields (32.91, 33.97, 33.21, 32.88, 34.13, and 33.11 ton ha^{-1}) were recorded at the treatment combinations of 69- kg ha^{-1}N from Urea + 46- kg ha^{-1}N from compost, 69- kg ha^{-}

[1]N from Urea + 69- kg ha^{-1}N from compost, 92- kg ha^{-1}N from Urea + 23- kg ha^{-1}N from compost, 92- kg ha^{-1}N from Urea + 46- kg ha^{-1}N from compost, 92- kg ha^{-1} N from Urea + 69- kg ha^{-1}N from compost and 46- kg ha^{-1}N from Urea + 69- kg ha^{-1}N from compost respectively; which clearly indicates the role of compost integrated with inorganic fertilizer on biomass yields as in that of plant height. This finding was confirmed with Getinet and Wassie (2019), in which the highest biomass yield of wheat was recorded at the combined application of 69 kg N ha^{-1} and 11.2 t ha^{-1} compost.

Moreover, the higher grain yields (4532, 4589.3, 4755.3, 4547.5, 4557.3, 4725.2, 4690.5, 4502.3, 4535.6, 4502.3 and 4591.8 kg ha^{-1}) were recorded at the treatment combinations of (69-N from Urea + 23-N from compost, 69-N from Urea + 46-N from compost, 69-N from Urea + 69-N from compost, 92-N from Urea + 0-N from compost, 92-N from Urea + 23-N from compost, 92-N from Urea + 46-N from compost, 92-N from Urea + 69-N from compost, 46-N from Urea + 23-N from compost, 46-N from Urea + 46-N from compost, 46-N from Urea + 69-N from compost and 23-N from Urea + 69-N from compost) respectively ; which were statistically at par between themselves. On the other hand, the least grain yield of 1904.0 kg ha^{-1} was obtained from plots that received zero compost and 23 kg ha^{-1} inorganic N fertilizer.

Table.1 Nitrogen and moisture content of the conventional compost prepared at Werer Agricultural Research center

Fresh weight [g]	Dry Weight [g]	Moisture content [%]	Nitrogen content [%]	Compost added [ton ha^{-1}]
162.01	78.64	48.54	0.53	8.61

**Compost added is the amount of compost added to obtain the recommended rate of Nitrogen per hectare i.e. 46 kg ha^{-1} of nitrogen.*

Table.2 Treatment set up of the experiment

Treatment	Fertilizer combination
1	23Nitrogen from Urea fertilizer + 0 N from compost
2	23Nitrogen from Urea fertilizer + 23 N from compost
3	23Nitrogen from Urea fertilizer + 46 N from compost
4	23Nitrogen from Urea fertilizer + 69N from compost
5	46Nitrogen from Urea fertilizer + 0N from compost
6	46Nitrogen from Urea fertilizer + 23N from compost
7	46Nitrogen from Urea fertilizer + 46N from compost
8	46Nitrogen from Urea fertilizer + 69N from compost
9	69Nitrogen from Urea fertilizer + 0 N from compost
10	69Nitrogen from Urea fertilizer + 23 N from compost
11	69Nitrogen from Urea fertilizer + 46N from compost
12	69Nitrogen from Urea fertilizer + 69N from compost
13	92Nitrogen from Urea fertilizer + 0N from compost
14	92Nitrogen from Urea fertilizer + 23 N from compost
15	92Nitrogen from Urea fertilizer + 46N from compost
16	92Nitrogen from Urea fertilizer + 69N from compost

Table.3 Selected soil physico -chemical properties of the study sites before sowing

Location	Textural classes	pH	EC (dS/m)	K (ppm)	A. P (mg/kg)	OM (%)	TN (%)
Werer	Silty Clay Loam	8.05	0.90	6.58	22.45	1.26	0.07
Fentale	Loam	7.74	0.385	1.57	26.30	1.91	0.11

*Notes: **pH** is potential of Hydrogen, **EC** (dS/m) is Electrical conductivity, **K (ppm**) is soluble potassium, **Avail. P** (mg/kg) is available phosphorus, **OM (%)** is Organic matter and **TN (%)** is Total nitrogen.

Table.4 The soil chemical properties after harvest at the two experimental sites

Trt no.	pH		EC (dS/m)		K (ppm)		A. P (mg/kg)		OM (%)		TN (%)	
	Werer	Fentale	Werer	Fentale	Werer	Fentale	Werer	Fentale	Werer	Fentale	Werer	Fentale
1	8.25	7.73	0.37	0.32	1.47	0.99	18.90	21.70	0.75	1.21	0.09	0.08
2	7.66	7.23	0.70	0.27	4.66	0.51	17.20	24.60	0.81	1.81	0.09	0.07
3	7.67	7.58	0.81	0.29	5.72	0.70	18.70	21.80	1.27	2.32	0.12	0.13
4	7.94	7.38	0.56	0.28	3.31	0.61	17.00	21.90	1.15	2.33	0.14	0.14
5	8.09	7.66	0.68	0.32	4.46	0.99	16.00	25.30	1.13	1.95	0.09	0.10
6	7.93	7.58	0.54	0.24	3.11	0.22	16.50	29.60	1.13	1.99	0.10	0.12
7	8.01	7.50	0.85	0.24	6.10	0.22	16.40	22.20	1.34	2.44	0.11	0.09
8	7.91	7.60	0.99	0.27	7.45	0.51	17.70	25.20	1.45	2.13	0.14	0.15
9	8.14	7.64	0.68	0.29	4.46	0.70	18.20	29.80	1.02	2.03	0.09	0.07
10	8.07	7.46	0.62	0.30	3.88	0.80	18.50	23.70	1.13	2.13	0.11	0.19
11	7.78	7.68	0.75	0.46	5.14	2.34	24.70	29.50	1.52	1.99	0.10	0.15
12	7.73	7.61	0.70	0.29	9.86	0.70	19.70	30.00	1.26	2.26	0.14	0.12
13	8.13	7.62	0.56	0.34	3.31	1.19	17.40	29.80	1.45	1.95	0.08	0.12
14	8.05	7.50	0.61	0.31	3.79	0.90	19.00	30.40	1.47	2.11	0.12	0.16
15	7.73	7.49	0.55	0.31	3.21	0.90	16.80	23.70	1.39	2.13	0.11	0.09
16	7.85	7.40	0.45	0.37	2.25	1.47	17.10	24.60	1.45	2.06	0.15	0.16

*Notes: **Trt no**. means Treatment number, **pH** is potential of Hydrogen, **EC** (dS/m) is Eletrical conductivity, **K (ppm**) is soluble potassium, **Avail. P** (mg/kg) is available phosphorus, **OM (%)** is Organic matter and **TN (%)** is Total nitrogen.

Table.5 ANOVA table of the main factors, two and three-way interaction of plant height, biomass yield and grain yield of maize in the two locations during 2016- 2018 cropping seasons

Source of variation	Parameters		
	Plant height (cm)	Biomass yield (ton ha^{-1})	Grain yield (kg ha^{-1})
Year	Ns	*	NS
Location	Ns	*	NS
Treatment	***	***	***
Year*Location	Ns	NS	NS
Year*Treatment	NS	NS	NS
Location*Treatment	NS	NS	NS
Year*Location*Treatment	NS	NS	NS
CV	*2.69*	*7.05*	*9.47*

**, **, = show significance at 5 and 1 % probability levels respectively, Ns =Non-significant*

Table.6 Effects of integrated nitrogen fertilizer with compost on plant height, biomass and maize grain yield at Werer Agricultural Research center and Fentale location during 2016, 2017 and 2018

Factors	Parameters		
	Plant height (cm)	Biomass yield (ton ha^{-1})	Grain yield (kg ha^{-1})
Year			
2016	222.93 a	27.62 b	4154.51 a
2017	223.39 a	28.18 ab	4196.05 a
2018	223.83 a	28.47 a	4238.01 a
Location			
WARC	223.61 a	28.37 a	4238.57 a
Fentale	223.15 a	27.80 b	4153.80 a
Fertilizer level			
23-N from Urea + 0-N from compost	213.28 h	19.94 e	1904.0 d
23-N from Urea + 23-N from compost	191.66 j	21.50 d	3378.8 c
23-N from Urea + 46-N from compost	219.55 g	24.54 c	3974.1 b
23-N from Urea + 69-N from compost	221.56 gf	27.42 b	4502.3 a
46-N from Urea + 0-N from compost	209.61 hi	21.50 d	3378.8 c
46-N from Urea + 23-N from compost	226.57 de	27.08 b	4535.6 a
46-N from Urea + 46-N from compost	228.77 cd	27.61 b	4502.3 a
46-N from Urea + 69-N from compost	227.90 cd	33.11 a	4591.8 a
69-N from Urea + 0-N from compost	209.27 i	24.56 c	3974.1 b
69-N from Urea + 23-N from compost	230.36 cd	27.52 b	4532.3 a
69-N from Urea + 46-N from compost	227.73 cde	32.88 a	4589.3 a
69-N from Urea + 69-N from compost	235.43 ab	34.13 a	4755.3 a
92-N from Urea + 0-N from compost	223.83 ef	27.55 b	4547.5 a
92-N from Urea + 23-N from compost	231.57 bc	32.91 a	4557.3 a
92-N from Urea + 46-N from compost	237.84 a	33.97 a	4725.2 a
92-N from Urea + 69-N from compost	239.18 a	33.21 a	4690.5 a
CV	*2.69*	*7.05*	*9.47*
LSD	*3.96*	*1.30*	*261.21*

Means with the same letter in each column are not significantly different at (α = 0.05)

Table.7 Effects of compost and inorganic fertilizer on economic profitability of maize production in Fluvisols of the middle Awash Valley of Ethiopia

Treatment	Maize grain yield (kg /ha)	Gross field benefit (ETB /ha)	Costs of fertilizer (ETB/ha)		Total variable cost (TVC)	Net benefit (ET)	Dominance
			Urea	Compost preparation			
23-N from Urea + 0-N from compost	1904	15232	550	0	550	14682	-
46-N from Urea + 0-N from compost	3378.8	27030.4	1100	0	1100	25930.4	2045.2
23-N from Urea + 23-N from compost	3378.8	27030.4	550	0	1350	25680.4	D
69-N from Urea + 0-N from compost	3974.1	31792.8	1650	0	1650	30142.8	765.89
23-N from Urea + 46-N from compost	3974.1	31792.8	550	1200	1750	30042.8	D
46-N from Urea + 23-N from compost	4535.6	36284.8	1100	800	1900	34384.8	1696.8
23-N from Urea + 69-N from compost	4502.3	36018.4	550	1600	2150	33868.4	D
92-N from Urea + 0-N from compost	4547.5	36380	2200	0	2200	34180	D
46-N from Urea + 46-N from compost	4502.3	36018.4	1100	1200	2300	33718.4	D
69-N from Urea + 23-N from compost	4532.3	36258.4	1650	800	2450	33808.4	D
46-N from Urea + 69-N from compost	4591.8	36734.4	1100	1600	2700	34034.4	D
69-N from Urea + 46-N from compost	4589.3	36714.4	1650	1200	2850	33864.4	D
92-N from Urea + 23-N from compost	4557.3	36458.4	2200	800	3000	33458.4	D
69-N from Urea + 69-N from compost	4755.3	38042.4	1650	1600	3250	34792.4	30.193
92-N from Urea + 46-N from compost	4725.2	37801.6	2200	1200	3400	34401.6	D
92-N from Urea + 69-N from compost	4690.5	37524	2200	1600	3800	33724	D

Fig.1 Poor irrigation water management that aggravates salinization, Photos from my Observation at Fentale Area, Oromia Region and Amibara Area, Afar region respectively

Fig.2 Reclamation of Salt affected soil in Amibara Area, Afar Region, Ethiopia

Fig.3 Location map of the study site of Amibara and Fentale Woredas

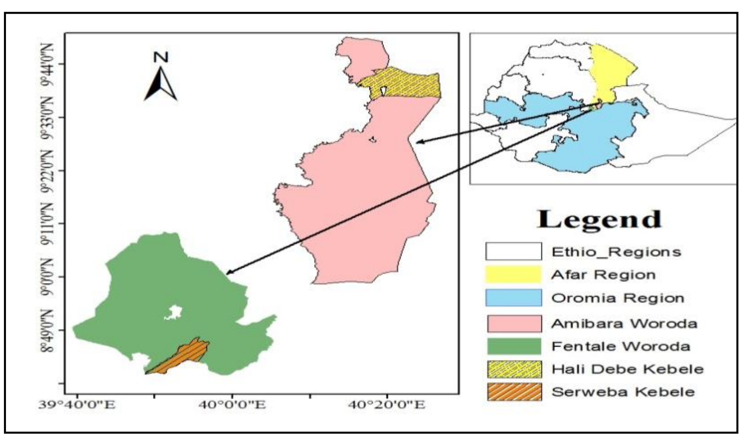

Fig.4 Photos during remixing of digested compost

Fig.5 Crop field performance at Fentale Area of Oromia Region

The probable reason for these nearly higher grain yields across the treatments were also due to the integrated application of N-equivalent compost with inorganic urea fertilizer rates. Similar findings were suggested by Wakene *et al.*, (2001), Getinet and Wassie (2019), in which higher grain yields were recorded at the higher combination rates of inorganic fertilizer with compost. The recorded higher grain yields at the integration of compost with inorganic fertilizer indicates the effectiveness of integrating organic and inorganic sources to improve nutrient use efficiency of plants; which resulted in improved grain yields (Getinet and Wassie, 2019).

Economic analysis

The data related to grain yield under different level of combination of Urea and compost fertilizers were also subjected to partial budgeting. The results of the partial budget analysis reported in Table 7 indicated that the highest net benefit of ETB 34385.0 with acceptable MRR (1696.8%) was achieved from the combined application of 46-kg N from Urea and 23-Kg N from compost (ha^{-1}). The highest MRR (2045.2 %) with the second highest net benefit of ETB 25930.00 was obtained from the sole application of 46-kg N from Urea (ha^{-1}).

Since the minimum acceptable rate of return assumed in this experiment was 100%, the treatments with the sole application of 69 kg N ha^{-1} from Urea had also met the requirement. However, the highest MRR was obtained from the sole application of 46 kg N ha^{-1} from Urea.

Besides, the results of economic analysis showed that combined application of 46-kg N from Urea and 23-Kg N from compost (ha^{-1}).were economically an alternative dose. The net benefit increased by birr 8454 over 46 kg N ha^{-1} from Urea through combined application 46-kg N from Urea and 23-Kg N from compost (ha^{-1}).

The result of this experiment has evaluated the combined applications of compost with different levels of nitrogen fertilizer rates. Generally, integrated application of N-equivalent compost, with inorganic fertilizer (urea) rates had showed the greater yield advantages than the sole application of inorganic fertilizer. In this study, combined application of 46 kg N from Urea and 23 kg N from compost (ha^{-1}) produced optimum grain yield and realized the maximum net benefit with the 2^{nd} highest MRR next to 46 kg N ha^{-1} mineral fertilizer. Thus, to enable sustainability of soil health, combinations of 46 kg N ha^{-1} with 23 kg N from compost could be suggested for the area. The finding of this study implies the effectiveness of integrated use of organic fertilizer with that of inorganic on enhancing Maize productivity.

Acknowledgement

The research is financed by Ethiopian Institute of Agricultural Research, EIAR

References

Abate, T., Shiferaw, B., Menkir, A., Wegary, D., Kebede, Y., Tesfaye, K., Kassie, M., Bogale, G., Tadesse, B. and Keno, T., 2015. Factors that transformed maize productivity in Ethiopia. Food security, 7(5), pp.965-981

Getachew Agegnehu and Taye Bekele, 2005. On-farm Integrated soil fertility management in wheat on nitisols of centreal Ethiopian highlands. Ethiopian Journal of Natural Resources.

Getachew Agegnehu, Angaw Tsigie, Agajie Tesfaye, 2012. Evaluation of crop residue retention, compost and inorganic fertilizer application on barley productivity and soil chemical properties in the central Ethiopian highlands. Ethiopian Journal of Agricultural Sciences, 22(1), pp.45-61

Getinet Adugna and Wassie Haile, 2019. Yield and Nitrogen Uptake of Wheat as Affected by Nitrogen Fertilizer and Compost in the Central Rift Valley of Ethiopia. Ethiopian Journal of Agricultural Sciences, 29(1), pp.85-97

Getinet Adugna, Habte Nida, Abere Mnalku, Sosena Amsalu, Melese Menaleshewa, 2016. A Review of Soil Fertility Improvement and Monitoring Studies on Cotton at Middle Awash and Arbaminch Areas, Ethiopia. Academic Research Journal of Agricultural Science and Research, 4(1), pp.18-30.

Gomez K. A and Gomez A A., 1984. Statistical Procedures for Agricultural Research. Second Edition. John Wiley &Sons, Inc. USA

Kimetu, J. M., Mugendi, D. N., Palm, C. A., Mutuo, P. K., Gachengo, C. N., Nandwa, S. and Kungu, J. B., 2004. Nitrogen fertilizer equivalency values for different organic materials based on maize performance at Kabete, Kenya. Academy of Science publishers, Nairobi, Kenya, pp.207-223.

Ofcansky, T. P. and Berry, L. B. eds., 1991. Ethiopia: A country study. Federal Research Division

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dep. of Agric. Circ. 939.

Richards, L. 1954. Diagnosis and Improvement of Saline and Alkali Soils. Agriculture handbook. United States Salinity Laboratory, Washington, USA.

SAS, 2003. Statistical analysis system: version 9.0, SAS Institute Inc, Cary, North Carolina, USA.

Wakene Negassa, Tolera Abera, Abdenna Deressa, and Berhanu Dinsa, 2001. Evaluation of compost for maize production under farmers' conditions. In Seventh Eastern and Southern Africa Regional Maize Conference (pp. 382-386).

Walkley, A. and Black, I. A. 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic soil titration method. *Soil Sci.* 37: 29–38.

Worku, A., Mamo, B. N. L. and Bekele, T., 2019. Evaluation of some selected forage grasses for their salt tolerance, ameliorative effect and biomass yield under salt affected soil at Southern Afar, Ethiopia. Journal of Soil Science and Environmental Management, 10(5), pp.94-102

How to cite this article:

Diriba Megersa Soboka, Mekuria Bekele and Bethel Nekir. 2022. Enhancing the Productivity of Salt-affected Soil through Application of Integrated Organic and Inorganic Fertilizers: The Case of Middle Awash Valley, Ethiopia. *Int.J.Curr.Res.Aca.Rev.* 10(06), 101-110. doi: https://doi.org/10.20546/ijcrar.2022.1006.009