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Effect of Integrated Farmyard Manure and NPS Fertilizer on Maize Yield and Yield Component at Adola Rede District of Guji Zone, Southern Ethiopia

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Abstract: Low soil fertility is one of the major factors limiting maize production and productiveness in maize growing areas of Ethiopia where fertilizer use is low and no agricultural residues are left to the soil for preserving soil fertility. A field experiment had been conducted in the Adola rede district of the Guji zone to evaluate the effects of integrated FYM and NPS fertilizer application on yield and yield components of maize. Five treatments, i) 7.8 ton ha^{-1} farmyard manure (FYM) + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$, ii) 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$, iii) 5.4 ton ha^{-1} farmyard manure (FYM) + 62.1/27.6/5.1 kg ha^{-1} $N/P_2O_5/S$, iv) 100/46/8.5 kg ha^{-1} $N/P_2O_5/S$ (Recommended charge of $N/P_2O_5/S$) and Control (without fertilizer and FYM application) were applied. The experiment used to be organized in a randomized complete block diagram (RCBD) with three replication. The collected data were subjected to ANOVA Genstat using the 18th edition. Results showed that the mixed application of farmyard manure and NPS fertilizer significantly ($P < 0.05$) affected plant height, number of ears per plant, and grain yield. Significantly the best grain yield (8873 kg ha^{-1}) and the number of ears per plant (1.5) were recorded from the mixed application of 6.6-ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$). The ear length and thousand seed weight had been now not significantly ($P < 0.05$) affected through NPS fertilizer and farmyard manure. Soil chemical properties such as pH, OC, Total N, available P, and CEC were increased under the utility of farmyard manure with inorganic fertilizer NPS. In conclusion, combined application of 6.6 ton ha^{-1} farmyard manure (FYM) with 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$ can preserve the maize production in the study area and alike agro ecology.

Keywords: Grain Yield, Inorganic Fertilizer, Farmyard Manure, and Recommended Fertilizer Rate

1. Introduction

Maize (Zea mays L.) is the most necessary cereal crop global [4]. In Africa, Ethiopia is the third greatest maize producer next to Nigeria and Egypt [8]. Maize ranks second after teff in locality coverage and first in total manufacturing in Ethiopia [6].

Low soil fertility is one of the main elements restraining maize production and productivity in maize-growing areas of Ethiopia where fertilizer use is low and no agricultural residues are left to the soil for fundamental soil fertility [1]. Emerging lookup results from a range of components of Ethiopia demonstrated worryingly low soil organic matter (SOM) and deficiencies of elements such as nitrogen (N), phosphorus (P), potassium (K), sulfur (S), boron (B), and copper (Cu) as the essential causes of crop yield decline and non-sustainable agricultural production [7, 13, 15, 16]. The troubles are attributed to non-stop cropping of the equal land year after year, insufficient replenishment of the lost nutrients, entire residue removal from the field, and soil erosion [6]. To limit soil nutrient depletion, fertilizers, namely, organic, inorganic, or their integration are used as the source of essential plant nutrients.

Organic farmyard manures combined with inorganic

fertilizers often lead to extended soil organic matter (SOM), soil structure, water-holding capacity, and increased nutrient cycling and help to maintain soil nutrient status, Cation exchange capability (CEC), and soil's organic activity [21]. Although chemical fertilizers are an important enter to get greater crop productivity, over-dependence on chemical fertilizers is related with the decline in some soil properties and crop yields over time [10]. Therefore, integrated use of inorganic fertilizers with organic farmyard manure is a sustainable method for environment friendly nutrient utilization which enhances the efficiency of the chemical fertilizers whilst decreasing nutrient losses [22]. Synergistic consequences of organic manures with inorganic fertilizers accumulate extra total nitrogen in soils [11], however the sole utility of farmyard manure (FYM) resulted in an expanded yield of maize [2], greater SOM content (44%), multiplied soil porosity (25%) and sixteen instances extra water holding capacity [9]. A long-term residual impact on soil organic C and soil P (about 7 to eight years) was once said by means of [14] when organic manure was applied in semi-arid dry land agriculture. Organic manures additionally have an effect on the soil's biological activities [3], whilst more suitable phosphorous (P) availability is additionally properly suggested with the application of organic manures in the soil [25].

Subsequently, there is a need to draw a mid-way between organic and inorganic extremities that may additionally sustain crop yields without deteriorating soil fertility and/or productivity. Keeping all these elements in consideration, the present study was therefore conducted to evaluate the effects of farmyard manure and inorganic fertilizer on the growth and yield of maize in the area.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in the main season of 2019 and 2020 at Adola rede District of Guji zone, Oromia Regional State, Ethiopia. Adola rede District is one of the most vital maize-producing areas of the region. Adola rede District is positioned between 5°44'10"- 6°12'38" northing latitudes and 38°45'10"- 39°12'37" easting longitudes and at an altitude of 1500-2000 meters above sea level. The District is bordered with Girja district in the northeast, Anna sora in North West, Oddo shakkiso in the south, and Wodera in the Southeast direction. The long-term (thirty years) imply annual rainfall of the study area was 1126.0 mm with a maximum and minimum temperature of 21.4°C to 28.5°C and 9.9°C to 15.0°C respectively.

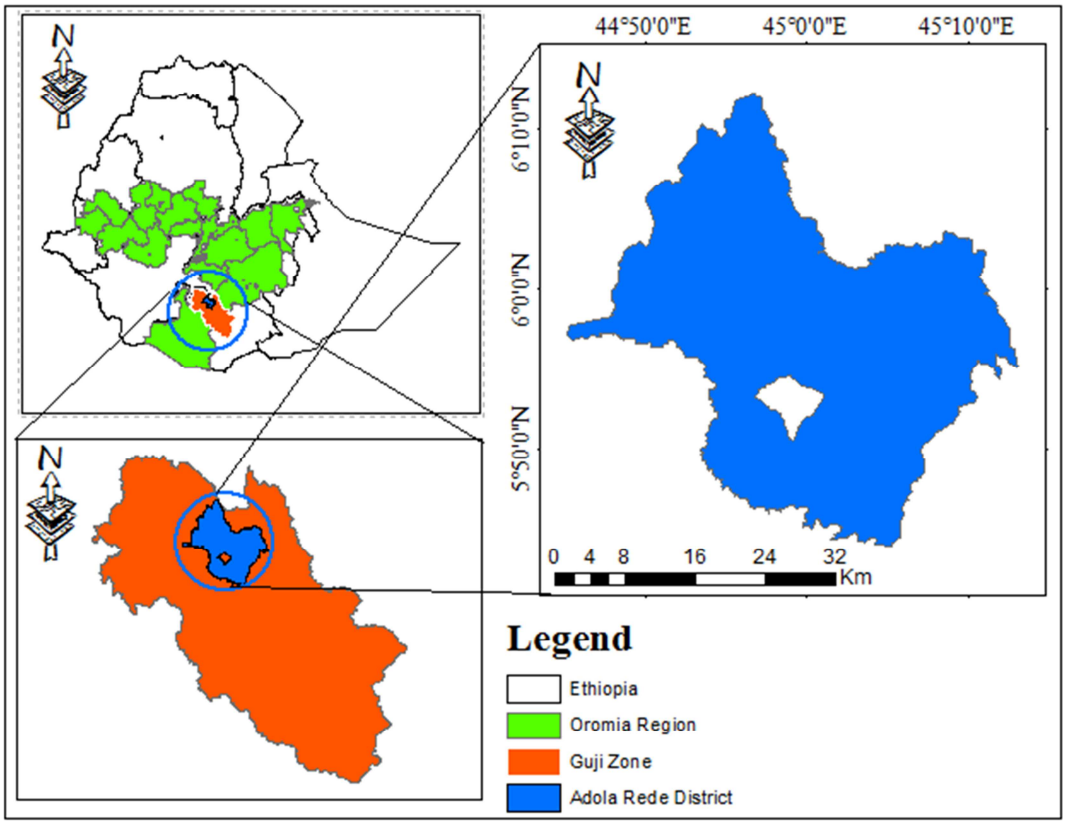

Figure 1. *Location Map of the study area.*

2.2. Initial Soil Fertility Status

To characterize the soil of the experimental fields, a composite sample was collected at depth of 0-30 cm in a zigzag manner using an auger from the whole field before planting and from each plot after harvesting to study the residual impact on selected soil chemical and physical

properties. The consequences exhibit that the experimental soil was clay in textural class. The physical and chemical properties of the soil earlier than planting are shown in (Table 1).

Table 1. *Selected Physico-chemical properties of the soil of the experimental site before planting at Adola Rede District.*

pH (H_2O)	N (%)	OC (%)	Av.P (mg kg^{-1})	CEC (cmolkg^{-1})	Sand%	Clay%	Silt%	Soil textural class
5.34	0.16	2.20	5.94	9.41	32	48	20	Clay

2.3. Characterization of Farmyard Manure Used in the Experiments

The farmyard manure used in the experiment was analyzed for pH, total N, available P, organic carbon, and organic matter following the approaches as outlined through [18]. Table 2 suggests the outcomes of farmyard manure characterization.

Table 2. *Some chemical composition of the farmyard manure used in the experiments.*

pH (H_2O)	N%	Av. P (ppm)	OC%	OM%
8.18	0.97	434.70	13.04	22.59

2.4. Experimental Design and Treatments

The experiment was carried out with 5 treatments, i) 7.8 ton ha^{-1} farmyard manure (FYM) + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$, ii) 6.6 ton ha-1 farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$, iii) 5.4 ton ha^{-1} farmyard manure (FYM) + 62.1/27.6/5.1 kg ha^{-1} $N/P_2O_5/S$, iv) 100/46/8.5 kg ha^{-1} $N/P_2O_5/S$ (Recommended fee of $N/P_2O_5/S$) and Control (without fertilizer and FYM application). The blended NPS fertilizer (19N–38P_2O_5-0K-7S grade) rates had been set based on N and P_2O_5 recommendation of maize at the Adola rede region (100 kg ha^{-1} N and 46 kg ha^{-1} P_2O_5). The Farmyard manure rates had been calculated on a dry weight bases and utilized to the respective experimental plots. The treatments were arranged in Randomized Complete Block Design (RCBD) with three replications.

2.5. Experimental Procedures and Crop Management

The field was prepared by ploughing three times. The N content of farmyard manure (FYM) was computed before application to determine the application rate of farmyard manure for each treatment, which was based on recommended N equivalent rate for the test crop. The entire doses of organic fertilizers (FYM) as per the treatment were utilized into the soil two weeks earlier than sowing of the test crop Maize (variety BH 661). It is incorporated into the soil and entirely combined in the top 15 to 20 cm soil depth by of human power. The maize was hand planted on a plot size of 11.25m^2 (3.75 m width and 3 m length) with 75cm × 25cm between rows and plant, respectively. Two seeds were placed per hill to make certain the preferred stand in every cure and thinned at 3-4 leaves stage to one plant. Blended NPS fertilizer was utilized at the spot for every plant at the time of planting. The remaining nitrogen was calculated and utilized in split at 30 days after emergence for every treatment. Then, all the final vital agronomic practices and crop management things to do had been undertaken.

2.6. Data Collected

(1) *Plant Height (cm):* Plant height (cm) was decided from the base to the tip of the tassel (from 12 randomly chosen plant life per plot).
(2) *The number of ears per plant:* it was once acquired by using counting the whole number of ears in each plot and divided into the total number of plant stands harvested.
(3) Ear length (cm): it used to be measured for twelve randomly chosen ears from the base to the tip of the ear at maturity.
(4) *Thousand Seed weight (g):* ears had been chosen randomly from twelve plants and thousand seed weight was measured by means of counting a thousand seeds using a seed counter and weighed using touchy balance at harvesting and adjusted at 12.5% moisture.
(5) *Grain yield (kg ha^{-1}):* grain yield per plot was recorded using sensitive balance and then adjusted to 12.5% moisture and converted to a hectare basis.

2.7. Statistical Analysis

The Effect of integrated Farmyard manure and NPS fertilizer on maize yield and yield components was evaluated using different statistical methods. Analysis of variance (ANOVA) was performed for crop data using Genstat 18th edition. Soil data were subjected to descriptive statistics. When the effects of treatments were significant, the mean comparison was performed using least significance differences (LSD) at a 5% probability level.

3. Results and Discussion

3.1. Soil Nutrient Status after Harvest

3.1.1. Soil pH

The soil pH after harvest was increased under all treatments when in compared to the preliminary soil pH 5.34 (Table 3). The maximum and minimum PH value was recorded under 7.8 ton ha^{-1} farmyard manure + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$ and 100/46/8.5kg$ha^{-1}$$N/P_2O_5/S$ (Recommended rate of $N/P_2O_5/S$) respectively. High farmyard manure in the soil can take in or bind hydrogen ions in its humus varieties whilst utility of N fertilizers add hydrogen ions to the soil, hence, high acidity. These results agree with [17] who pronounced a regularly occurring reduction in acidity after organic and mineral fertilizers application.

3.1.2. Soil Total Nitrogen

Numerically among the treatments, the highest soil total nitrogen (0.19%) was recorded from the application of 7.8 ton ha^{-1} farmyard manure + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$, observed with the application of 5.4 ton ha^{-1} farmyard manure + 62.1/27.6/5.1 kg ha^{-1} $N/P_2O_5/S$ which was resulted in the soil total nitrogen (0.18%). After harvest, the lowest total N (0.13%) was recorded from the control (Table 3). When compared with control the soil total nitrogen was improved by 31.6% and 27.8% at the application of 7.8 ton ha^{-1} farmyard manure + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$ and 5.4 ton ha^{-1} farmyard manure + 62.1/27.6/5.1 kg ha^{-1} $N/P_2O_5/S$ respectively. As shown in Table 3 the soil total N was enhanced in all treatments when compared to control (0.13%). The finding was supported through [11] who said application of organic manures with inorganic fertilizers accumulates extra total nitrogen in soils. Table 3: Effect of NPS fertilizer and Farmyard manure on some selected chemical properties of soil after harvest.

Table 3. *Effect of NPS fertilizer and Farmyard manure on some selected chemical properties of soil after harvest.*

Treatments	pH (H_2O)	N (%)	OC (%)	Av.P (mg kg^{-1})	CEC (cmolkg^{-1})
Control	5.66	0.13	0.02	5.22	10.38
7.8 ton ha^{-1} FYM + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$	7.54	0.19	0.07	6.56	13.45
6.6 ton ha^{-1} FYM + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$	6.12	0.16	0.06	6.24	12.88
5.4 ton ha^{-1} FYM + 62.1/27.6/5.1 kg ha^{-1} $N/P_2O_5/S$	5.64	0.18	0.05	5.98	12.69
100/46/8.5kgha^{-1} $N/P_2O_5/S$ (Recommended rate of $N/P_2O_5/S$)	5.55	0.16	0.02	6.34	10.38

*FYM=Farm Yard Manure

3.1.3. Available Soil Phosphorus

The highest available P (6.56 mg kg^{-1}) was recorded from application of 7.8 ton ha^{-1} farmyard manure + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$, whereas the lowest available P (5.22 mg kg^{-1}) was got from the control (Table 3). The available soil Phosphorus was increased by 9.5 under application of percent 7.8 ton ha^{-1} farmyard manure + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$ as compared to the control. Changes in soil available P have been usually low in all treatments due to P being distinctly motionless and strongly adsorbed by soil particles [12], P uptake of the crop, and its transformation in the soil [23]. The use of organic manure has been proven to enlarge the amount of soluble organic depend which are more often than not organic acids that increase the rate of desorption of phosphate and therefore enhance available P content in the soil [27].

3.1.4. Soil Organic Carbon (SOC)

After harvest in all treatments, the soil organic carbon was reduced when in compared to the preliminary soil organic carbon (2.2%) (Table 3). The maximum soil organic carbon (0.07) was acquired with 7.8 ton ha^{-1} farmyard manure + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$ application in compared with the control (0.02). Overall, it was referred to that the utility of farmyard manure with inorganic had a high quality effect on soil OC of cultivated lands. This might exhibit that farmyard manure has a high quality function in improving soil organic carbon. The finding was supported by [21] who suggested that soil OC increased significantly under farmyard manure remedy plots.

3.1.5. Cation Exchange Capacity (CEC)

The highest Cation exchange capacity (13.45 cmolkg^{-1}) was recorded under treatment of 7.8 ton ha^{-1} farmyard manure + 20.7/9.2/1.7 kg ha^{-1} N/P2O5/S compared with control (10.38 cmolkg^{-1}) (Table 3). Cation exchange capacity was increased in all treatments except under control and recommended rates of NPS fertilizer. [26], encouraged the use of organic amendments given that chemical fertilizers do no longer make a contribution much over time to soil quality. Integration of minerals with organic fertilizer will increase soil fertility over the improvement of the physical and chemical properties of soil.

3.2. Yield and Yield Component of Maize

Table 4. *Effect of integrated Farmyard manure and NPS fertilizer on maize yield and yield component.*

Treatments	Plant height (cm)	Number of ears per plant	Ear Length (cm)	Thousand-grain weight (gm)	Grain yield (Kg/ha)
Control	257.8b	1.017c	30.97	399.2	5051d
7.8 ton ha^{-1} FYM + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$,	300.2a	1.3ab	32.51	400	7042bc
6.6 ton ha^{-1} FYM + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$	295.1a	1.5a	36.72	414.2	8873a
5.4 ton ha^{-1} FYM + 62.1/27.6/5.1 kg ha^{-1} $N/P_2O_5/S$	298.8a	1.207bc	36.37	412.5	6353bc
100/46/8.5kgha^{-1} $N/P_2O_5/S$ (Recommended rate of $N/P_2O_5/S$)	305.6a	1.433a	33.85	411.7	8251ab
$LSD_{0.05}$	31.83	0.1956	5.371	29.32	1414.8
CV (%)	9.1	12.7	13.2	6	16.5
Mean	291.5	1.291	34.08	407.5	7114

FM= Farm Yard Manure and Means with the same letter in each column are not significantly different at $p<0.05$.

3.2.1. Plant Height

Plant height was significantly (P <0.05) affected by using NPS fertilizer and farmyard manure (Table 4). Numerically, the longest plant height (305.6cm) was recorded from the application of 100/46/8.5 kg ha^{-1} N/P_2O_5/S (recommended rate of NPS), which was no statically significant with other treatments except control. The shortest plant height (257.8cm) was recorded from the control (Table 4 and Figure 2). The plant was increased by 15.64% at the application of 100/46/8.5 kg ha^{-1} N/P_2O_5/S (recommended price of NPS) when in compared to control. The increased in plant height with the growing rate of NPS fertilizer and compost ought to be due to their synergistic effects. Nitrogen is considered one of the essential limiting nutrients in plant growth and an ample provide of it promotes the formation of chlorophyll which in turn resulted in greater photosynthetic activity, lively vegetative growth, and taller plants. P is required for shoot and root development where metabolism is high and cell division is rapid. Similarly, sulfur in blended NPS fertilizer promotes the formation of chlorophyll, higher photosynthetic activity, lively vegetative growth, and taller plant life [20]. Similar findings were suggested by [24] who recorded the highest plant height of maize crop from the combined software of full NPS fertilizer with 9.2 ton ha^{-1} compost.

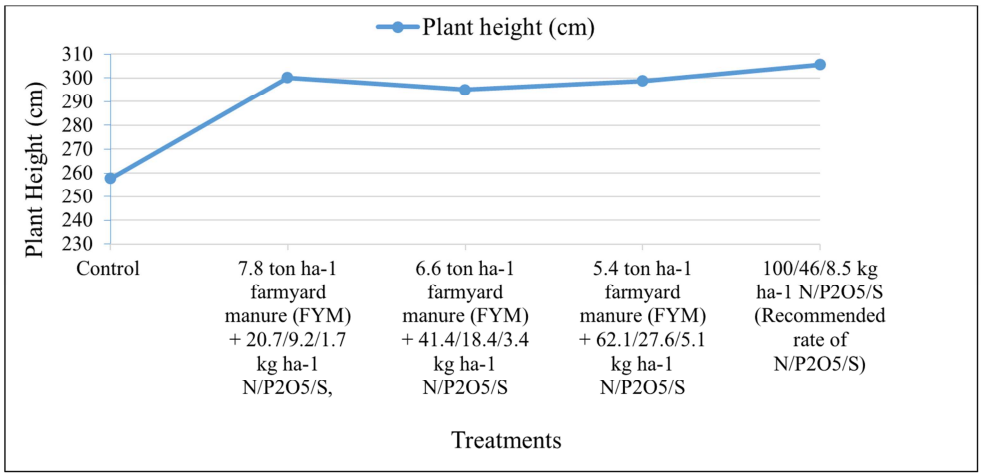

Figure 2. *Effects of integrated farmyard manure and NPS fertilizer on plant height of Maize at Adola rede District.*

3.2.2. Number of Ears Per Plant

Numerically the maximum number of ears per plant (1.5) was recorded at 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} N/P_2O_5/S. But its effect was not statistically significant from 100/46/8.5 kg ha^{-1} N/P_2O_5/S (Recommended fee of N/P_2O_5/S) and 7.8 ton ha^{-1} farmyard manure (FYM) + 20.7/9.2/1.7 kg ha^{-1} N/P_2O_5/S, whereas the minimum number of ear per plant (1.017) was recorded from the control (Table 4). Application of 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} N/P_2O_5/S increased the number of ears per plant with the application of 32.2% over the control (Table 4 and Figure 3).

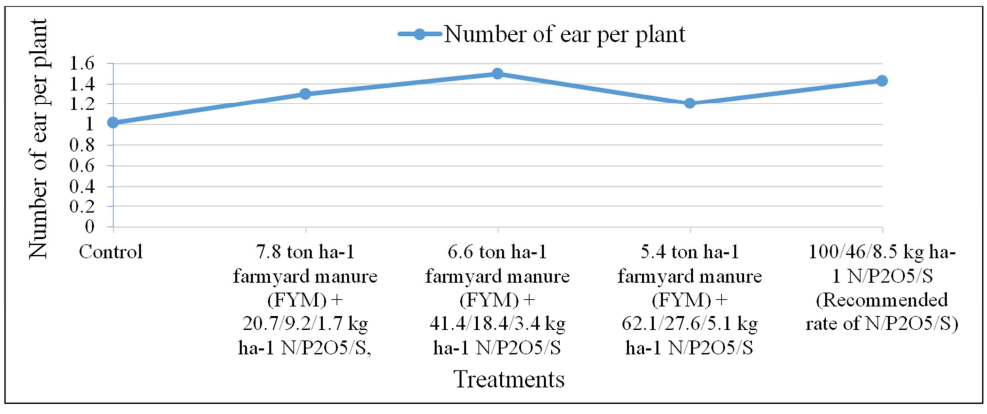

Figure 3. *Effects of integrated farmyard manure and NPS fertilizer on number of ears per plant of Maize at Adola rede District.*

This may be due to the release of nutrients slowly from the farmyard manure that increased the ears harvested per plant. Also, it could be related to improved soil fertility, which in turn had increased the nutrient availability for integral plant growth and for this reason may have increased the number of ears per plant. These outcomes had been in line with the findings of [24] who indicated that the mixed application of NPS fertilizer with organic

fertilizer increased the number of ears per plant compared to the control plot.

3.2.3. Ear Length

The yield of the maize crop is affected with altered influences which the ear length has a strong position. The longer the ear length, the better will be the yield of the maize crop. Ear size of maize was significantly ($p < 0.05$) influenced through different applications. The ear length was various from 36.72 cm underneath 6.6-ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$ to 30.97 cm beneath manage in which, which shows 15.65% ear length improved in contrast to control (Table 4). Data regarding the ear length of maize crop showed the maximum value of 36.72 cm that was bought from 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$ whereas the minimal 30.97 number was recorded from the control.

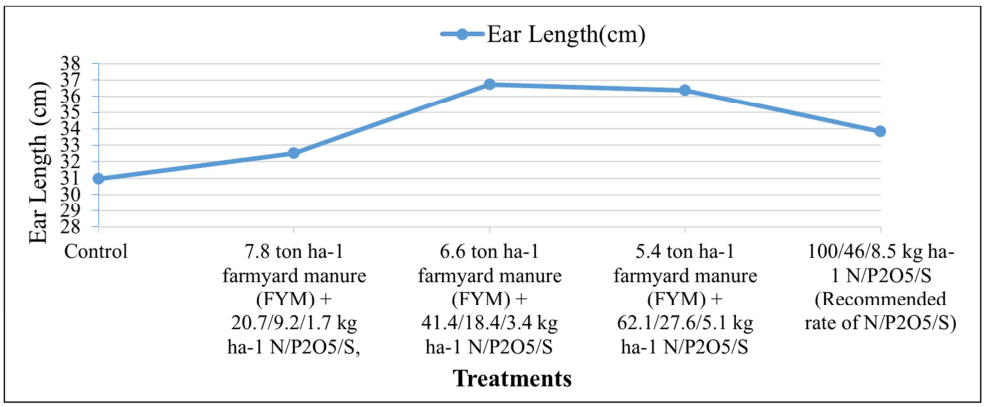

Figure 4. *Effects of integrated farmyard manure and NPS fertilizer on ear length of Maize at Adola rede District.*

3.2.4. Thousand-Grain Weight

The heavier thousand-grain weight (414.2 gm) was recorded from 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$ which was no statistically significant from the different treatments, whilst the lighter thousand-grain weight (399.2gm) was recorded from the control (Table 4 and Figure 5). There was an increment of 3.6% thousand-grain weight at 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$ application when compared with the control. An increase in thousand-grain weights was due to the outcomes of N for grain filling and will increase the plumpness of grains, P for cell division, seed formation, and development, S for seed production and farmyard manure in addition to the supply of nutrient, it improves soil structure and water absorption which helps for heavier grain weight of maize. Bigger sized ear may have accommodated extra wide number of grains supplying adequate space for the improvement of an individual grain, leading to a higher thousand-grain weight at adequate NPS fertilizer and farmyard manure. These results were in line with the report of [24] who reported that higher values of thousand-grain weight with an application of combined of NPS and organic fertilizer compared to control.

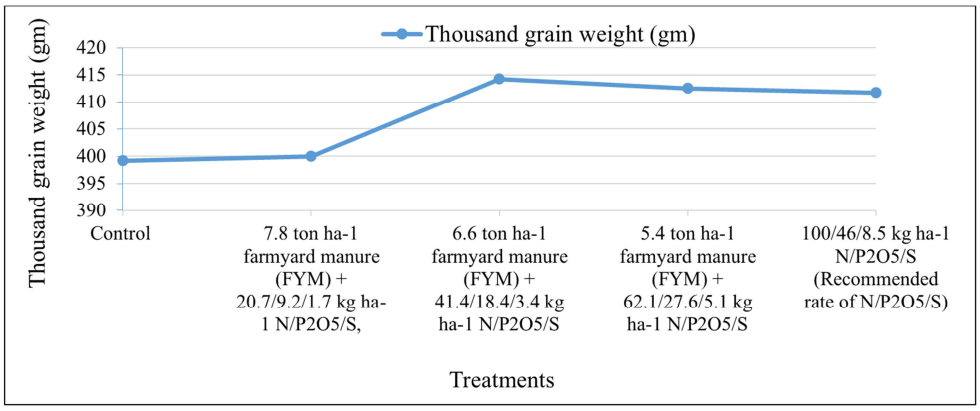

Figure 5. *Effects of integrated farmyard manure and NPS fertilizer on the thousand-grain weight of Maize at Adola rede District.*

3.2.5. Grain Yield

Grain yield of maize was significantly ($p < 0.05$) different due to different applications of farmyard manure and NPS fertilizer that differ between 5051 kg ha^{-1} (control plot) and 8873 kg ha^{-1} (under 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$) (Table 4). Grain yield of maize was raised via 43.07% due to the combined application of 6.6-ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg

ha^{-1} N/P_2O_5/S) over the control. Even though this application was statistically non-significant with the recommended rate of N/P_2O_5/S, it showed a 7% grain yield advantage. Also, a 28.27% of grain yield was obtained due to the application of 7.8-ton ha^{-1} farmyard manure (FYM) + 20.7/9.2/1.7 kg ha^{-1} N/P_2O_5/S over the control (Figure 6). The decrease of grain yield in unfertilized plots would possibly be due to nutritional imbalance and deficiency certain important plant growth elements at various important growth stages and also due to reduced leaf area development resulting in lesser radiation interception and consequently, low efficiency in the conversion of solar radiation.

It is clear from the end result that grain yield increased in response to the application of both NPS and farmyard manure possibly due to plant height, the number of grains per ear, ear length, and thousand-grain weight. The high crop improvements with farmyard manure than these received with the control were probable attributed to the improvement of the physical conditions and biological activities of the soil [5]. These results were also supported by the findings with [19] who reported the highest grain yield of 7179 kg ha $^{-1}$ was produced with the application of FYM 10 t ha^{-1} + 100% recommended dose of fertilizer.

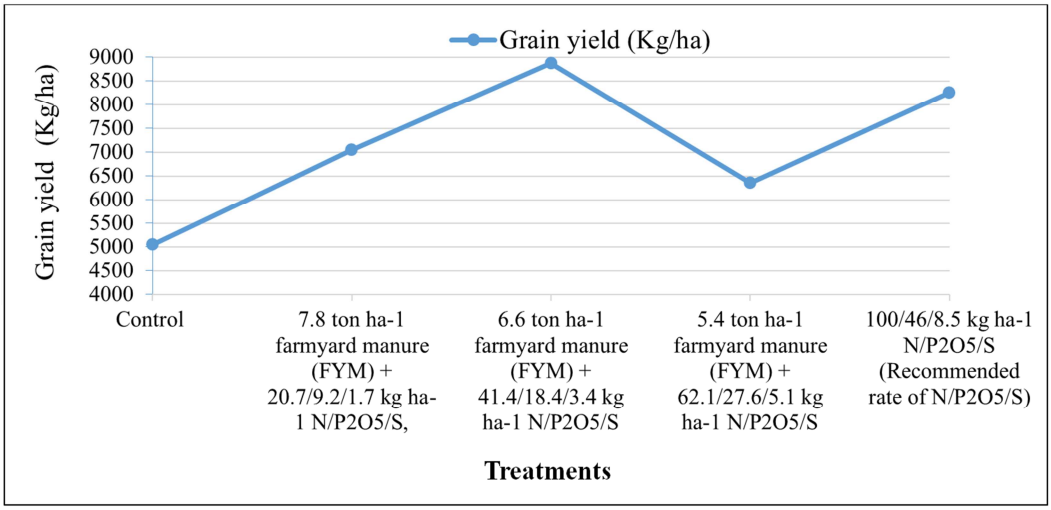

Figure 6. *Effects of integrated farmyard manure and NPS fertilizer on grain yield of Maize at Adola rede District.*

3.3. Correlation Analysis

The correlation revealed remarkable relationships between the grain yield and yield components. Grain yield was large and positively correlated with plant height (r = 0.744, P<0.01), number of ears per plant (r = 0.377, P<0.05), thousand seed weight (r = 0.368, P<0.05 (Table 5). Therefore, significant and positively correlated moves in the same direction this means that as one variable increases, so does the other one while significant and negatively correlated parameters moves in the inverse or opposite direction. In other words as one variable increases the other variable decreases.

Table 5. *Pearson correlation coefficients among different yield and yield components of maize.*

	PH	NEPP	EL	TSW	GY
PH	1				
NEPP	0.381*	1			
EL	0.320	0.099	1		
TSW	0.294	0.103	0.202	1	
GY	0.744**	0.260	0.377*	0.368*	1

*. = Correlation is significant at 5, **. = Correlation is significant at 1% level, PH = Plant Height, NEPP =Number of ear per plant, EL =Ear length, TSW =Thousand seed weight and GY = Grain yield.

4. Conclusion

The predominant aim of this study was to evaluate the effect of farmyard manure and inorganic fertilizer on maize grain yields and yield components in the Adola rede District. The result gained in this study show that: Yields were significantly affected by the different treatments of farmyard manure and mineral fertilizers produced yields that have been remarkably greater than the values received from control. The highest grain yield was received by using 6.6-ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} N/P_2O_5/S) while the lowest grain yields were obtained from control. Even although it was statistically non-significant with the recommended value of N/P_2O_5/S, the grain yield of maize was increased by 43.07% due to the combined application of 6.6-ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} N/P_2O_5/S) over the control. Plant height was significantly (P <0.05) affected via NPS fertilizer and farmyard manure. Numerically, the longest plant height (305.6cm) was recorded from the application of 100/46/8.5 kg ha^{-1} N/P_2O_5/S (recommended rate of NPS), which was not statically different with other treatments except control. The maximum number of ears per plant (1.5) was recorded at 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} N/P_2O_5/S. But its effect was now not statistically different from 100/46/8.5 kg ha^{-1} N/P_2O_5/S (Recommended fee of N/P_2O_5/S)

and 7.8 ton ha^{-1} farmyard manure (FYM) + 20.7/9.2/1.7 kg ha^{-1} $N/P_2O_5/S$. Soil chemical properties such as pH, OC, total N, available P, and CEC were increased under the application of farmyard manure with inorganic fertilizer NPS.

5. Recommendations

Under Adola rede condition, the combined application of farmyard manure and NPS fertilizers at 6.6 ton ha^{-1} farmyard manure (FYM) + 41.4/18.4/3.4 kg ha^{-1} $N/P_2O_5/S$) can be recommended. Long-term studies of the treatments used in this study should be carried out to further determine their effects on the physical and chemical properties of the soil. Moreover, it is possible to suggest that, additional, research for a longer period using different rates of farmyard manure and inorganic fertilizer in the different ecological zones of Adola rede District should be conducted to come up with a strong figure on the optimum rates of NPS and farmyard manure for increased maize production.

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