Int.J.Curr.Res.Aca.Rev.2022; 10(09): 24-36

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 10 Number 09 (September-2022)

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

doi: https://doi.org/10.20546/ijcrar.2022.1009.004

Maize (*Zea mays* L.) Yield Response to the Effect of Balanced Fertilizer Types and N Rates under Rainfed Condition at Kersa and Omonada Districts Jimma Zone, Southwestern Ethiopia

Obsa Atnafu*

Ethiopian Institute of Agricultural Research, Jimma Agricultural Research Center, Jimma, Ethiopia

**Corresponding author*

Abstract

Maize is Ethiopia's most important cereal crop both in terms of level of production and area coverage. Imbalanced fertilization has caused lower yield and yield components of maize. Balanced fertilization refers to the application of essential plant nutrients in optimum quantities and proportions. Balanced nutrient supply is a best management practice that should also include proper application methods and timing for the specific soil crop-climate situation. Therefore, balanced fertilization is the key to sustainable crop production and maintenance of soil health. So field experiments were conducted from 2014–2015 at Kersa and Omonada districts in Jimma Zone, southwestern Ethiopia, to validate soil fertility map based on balanced fertilizer recommendation under various production environment and to quantify their comparative advantage over the traditional fertilizer recommendation on maize. Five mineral fertilizer treatments, recommended NP (92N and 69P_2O_5), 150kg/ha NPSB+140kg/ha urea top dressed, 150kg/ha NPSZnB +145kg/ha urea top dressed, 200kg/ha NPSZnB +120kg/ha urea top dressed and 200kg/ha NPKSZnB + 140 kg/ha urea top dressed were applied in a randomized complete block design replicated across on ten farmers' fields. The results showed that application of 150kgha^{-1} + 145 kgha^{-1} urea top dressed produced mean yield of 7212.4 kg ha^{-1} compared with 6449.9 kg ha^{-1} from recommended NP (92N+69P_2O_5) at Kersa. In Omonada, the highest grain yield was 6878.4 kg ha^{-1} obtained from the application of the same blended fertilizer 150kg/ha NPSB+140kg/ha urea top dressed. The highest yields in both sites were obtained during a rainy season. This study concluded that based on the annual and seasonal yields, the two blended fertilizers and the standard type had the same effectiveness, irrespective of clones and sites. However, the fertilizer rates affected the maize yield. Based on the study results, a balanced nutrient application using NPSB fertilization is a key management strategy for enhancing maize productivity and environmental safety. Therefore, based on the data obtained from this study application of 150NPSZnB kg/ha + 145 kg/ha urea top dressed will be recommended as profitable for the production of maize at Kersa and Omonada districts, South-western Ethiopia.

Article Info

Received: 05 August 2022
Accepted: 26 August 2022
Available Online: 20 September 2022

Keywords

balanced, fertilizers, soil fertility, sustainable, socioeconomic conditions, Maize.

Introduction

Maize is one of the pillar cereal crops ranking first in total production and productivity in Ethiopian agriculture, and second to tef in area coverage (Tekulu *et al.,* 2019). Maize is Ethiopia's most important cereal crop both in terms of level of production and area coverage. It is the second most widely cultivated crop in

Ethiopia and is grown under diverse agro-ecologies and socioeconomic conditions (Balemi *et al.*, 2019). There is evidence that the increased productivity and production of maize is also having a significant positive impact on poverty reduction (Dercon *et al.*, 2009; Zeng *et al.*, 2015). One of the main causes for this inconsistency is the low use of external inputs, leading to negative balances for N, P and K. In Ethiopia, Diammonium phosphate (DAP) and urea were the commonly used chemical fertilizers for crop production with having a common consideration of nitrogen and phosphorus were the major limiting nutrients for Ethiopian soils. The Ethiopian agricultural soils particularly the nitisols and other acid soils have low available P content due to their inherently low P content, high P fixation capacity, crop harvest and soil erosion (Chimdessa and Abdeta, 2019). Unless something is done to restore soil fertility first, other efforts to increase crop production could end up with little success (Sanchez *et al.*, 1997). Fertilizer application is a regular field management practice with a significant influence on yield (Cheruiyot *et al.*, 2009; Drinnan, 2008). Fertilizer use is a cornerstone in improving crop production and maintaining soil nutrient status (Chianu *et al.*, 2012). Chemical fertilizers with the ability to replenish depleted nutrients in optimum quantities and forms have been recognized as an important component of sustainable soil fertility management (Ogundijo *et al.*, 2015). A balanced requirement of a given nutrient refers to an amount of the nutrient required to meet a plant's needs while maximizing the use efficiency of the nutrient (Ezui *et al.*, 2016). Balanced applications of nutrients help plants in overcoming/tolerating biotic and abiotic stresses and thus ensure sustainable productivity (Datnoff *et al.*, 2006).

Crop growth and productivity depend on nutrient availability which is primarily influenced by soil pH and organic matter concentration (Chianu *et al.*, 2012; Kundu *et al.*, 2017). Fertilizer use will be crucial for raising and sustaining farm productivity in Africa (Jayne and Rashid, 2013). Sustainable crop production requires that at least the nutrients removed through exportation of agricultural products be returned to the soil, but nutrient imbalance in agricultural production is currently one of the main threats to soil in sub-Saharan Africa (Jones *et al.*, 2013; Montanarella *et al.*, 2016). However, sustainably increasing productivity, or even just increasing productivity, is not always as simple as adding fertilizer. Soil characteristics are a key factor affecting crop response to fertilizer, and hence the profitability of and demand for fertilizer (Burke *et al.*, 2017; Marenya and Barrett, 2009a; Matsumoto and Yamano, 2013).

Maize is an exhaustive crop having higher potential than other cereals and absorbs large quantities of nutrients from the soil during different growth stages. Nitrogen is a vital plant nutrient and a major yield determining factor required for maize production. It is very essential for plant growth and makes up one to four percent of the dry matter of the plants (Jeet *et al.*, 2012). Phosphorus is among the essential nutrients, which are the most important nutrients for higher yield in larger quantity and control mainly the reproductive growth of the plant (Khan *et al.*, 2014). In crop production, sometimes S is considered to be a forgotten secondary nutrient. However, it is most essential for the activity of proteolytic enzymes and the synthesis of amino acids (Sarfaraz *et al.*, 2014). Also, the application of micronutrients through fertilizers recovers plant growth and production. From the micronutrients, B is an important micronutrient for healthy crop growth (Saleem *et al.*, 2016).

A balanced requirement of a given nutrient refers to an amount of the nutrient required to 82 meet a plant's needs while maximizing the use efficiency of the nutrient (Ezui *et al.*, 2016). Application of plant nutrients may aggravate the depletion of other important nutrient elements in soils (Fayera *et al.*, 2014). The appropriate use of nitrogen and phosphorous fertilizer for sorghum production could make an important contribution to optimize profit through increasing production and productivity of sorghum in areas, where there is low practice of using improved technologies such as optimum level of fertilizer (Wako and Usmane, 2020). Not only phosphorus and nitrogen in form of dap and urea, application of potassium, sulfur and zinc in different parts of the country sharply increase yield which leads the country started using fertilizers which can supply the deficient nutrients and will continue to use in the form of blends /balanced (CSA, 2016).

Application of balanced fertilizer based on the actual limitation of nutrients in the soil is very crucial to increase production and productivity of crops. Balanced fertilizer amended with enough amount of nitrogen and phosphorous on sorghum gave the highest yield, nutritional content and economic return (Gebrekorkos *et al.*, 2017). Moreover, application of macronutrients in combination with micronutrient increased sorghum yield and concomitantly improved N, P and K uptake and its nutrient use efficiency of sorghum varieties (Weldegebriel *et al.*, 2018). Now a day, Agricultural Transformation Agency (ATA), has been conducted soil fertility survey and displays it on the map and also recommends different balanced fertilizer based on their map which is blanket recommendation. Thus why, those balanced fertilizer has to be checked and validated before going for calibration. And also, increasing yields through the application of nitrogen and phosphorus alone can deplete other nutrients. To overcome this problem of nutrient deficiency balanced fertilizers containing N, P, K, S, B and Zn in blended form are recommended to ameliorate site specific nutrient deficiencies and thereby increase crop productivity. Therefore, the core objective of this study was to validate soil fertility map based on balanced fertilizer recommendation under various production environment and to quantify their comparative advantage over the traditional fertilizer recommendation on maize at Kersa and Omo nada districts, southwestern Ethiopia.

Materials and Methods

Description of the study area

The study was conducted in two purposely selected districts (Kersa and Omo Nada) of Jimma Zone, Oromia Regional State, Ethiopia from December 2014 to January 2015. The Zonal capital, Jimma Town, is located 356 km away from Addis Ababa in southwest Ethiopia. The zone extends between $7^0 13'$–$8^0 56'$ North latitudes and $35^0 49'$–$38^0 38'$ East longitudes and also the altitude ranges from 1740 to 2660 m above sea level. Agriculture is the major source of economy, and it includes mainly the growing of coffee and cattle rearing. A comparative cross-sectional study was conducted in Kersa and Omo Nada districts of Jimma Zone, south-western Ethiopia during the main rainy season of 2014 and 2015. Farmers were systematically selected.

Geographically, Kersa district is located between 7°35′–8°00′N latitudes, 36°46′–37°14′E longitude and altitude that ranges from 1740 to 2660 m.a.s.l and consists of 10 percent dega, and 90 percent woinadega, agro ecologies. The main rainy season in Kersa area stretches from March to September and the area receives an average annual rainfall of 900-1300 mm. Temperatures are moderate ranking from 20-28^{O}C with variations across specific agro-ecologies.

Omo Nada district lies at 7°17’to 7°49’N 37°00’ to 37°28’E. It is located at a distance of about 71 kms from the zonal capital town, Jimma. It is bordered by Dedo in the west, Sokoru in the North, kersa in the South and Tiro Afata in the east. The rainfall of the area is bimodal, with unpredictable short rains from March to April and the main season ranging over June to September. The minimum and maximum annual rainfall ranges from 1066 to 1200mm with a mean annual temperature ranging from 18 to 25°C. The area is characterized by gentle, flat and undulating topography with the altitude ranging from 1650–2200 m.a.s.l. The land cover categories of the district comprises 26.5% potential arable or cultivable land which include23.4% annual crops and 7.0% pasture and 56.6% forest land and the remaining 9.9% was classified as degraded, built up or otherwise unusable.

Experimental plot was sandy clay loam in texture (sand: 45.77%, silt: 30.41% and clay: 28.82%) having pH (7.43 and 7.44). It was moderately fertile being low in organic carbon (0.32 and 0.34%). Nitisols are the dominant reference soil groups in coffee growing areas of southwest Ethiopia. Nitisols have a depth of more than 1.5 m, are clayey and red in color. They primarily occupy slopes steeper than 5%. These soils are well-drained with good physical properties; they have high water-storage capacity, a deep rooting depth, and stable soil aggregate structure. Nevertheless, rates of decomposition of organic matter and leaching of nutrients are extremely fast. Acidity ranges from medium to strong, and pH is generally less than 6 (Feyissa and Mebrate, 1994).

Experimental design and treatment

The experiments were laid out in randomized complete block design (RCBD) replicated across farmers’ fields per district in Kersa and Omonada on five farmers per each. The experiments were consisting total of five treatments including recommended blanket NP fertilizer with an amount of 92 kg N ha^{-1} and 69 kg P_2O_5 ha^{-1}andfourbalanced fertilizers (150kg/ha NPSB+140kg/ha urea top dressed, 150kg/ha NPSZnB +145kg/ha urea top dressed, 200kg/ha NPSZnB +120kg/ha urea top dressed and 200kg/ha NPKSZnB + 140 kg/ha urea top dressed) were used. A full dose of balanced fertilizer was applied at planting time close to seed drilling line, while N fertilizer was applied at knee height period for the N adjusted. Choice of the experimental fields was limited to farmer fields currently in crop production. The plot size used was 4.5m x 4.2 m (18.9 m^2). The experimental fields were prepared using a local plow (maresha) according to farmers’ conventional farming practices. The fields were ploughed two times to a depth of 15-20 cm and furrows were constructed by a handheld hoe. Bako hybrid maize (BH-661) which is high yielder as compared to other improved maize varieties in the study area was used as a test crop. A plant spacing of 80cm (inter-row) and 50 cm (intra-row) was used. Two seeds of maize were planted per hill. All recommended cultural practices (plowing, digging and weeding) for the test crop was done as per the recommendation of the area.

Results and Discussion

The effect of different fertilization treatments on maize yield was significant at each study site. In 2014/2015 (year one), the maize yields varied from 6156.9 to 6758.2 kg ha^{-1}at Kersa and 5705.9 to 6522.9 kg ha^{-1} at Omonada, while in 2015/2016 (year two), the yields ranged from 6775.3 to 7960 kg ha^{-1} and 6422.6 to 7271.8 kg ha^{-1} for Kersa and Omonada, respectively. When compared with recommended NP fertilizers, NPSB, NPSZnB and NPKSZnB fertilizations significantly increased the maize yield at both site. At both sites, the highest maize yield was observed under 150kg/ha NPSZnB+145kg/ha urea top dressed application followed by 150kg/ha NPSB + 140kg/ha urea top dressed and 200kg/ha NPSZnB + 120kg/ha urea top dressed, while the lowest yield was observed under recommended NP fertilization.

Growth Parameters

Plant height

The mean of plant height and the analysis of variance are shown in (Table 1). However, there were no significant differences amongst the plots treated with blended fertilizers types and the blanket recommendation of NP fertilizers. The highest plant height 304 cm and 308.5 cm was recorded from 150 kg ha^{-1} NPSZnB and 145 kg ha^{-1} urea top dressed at Kersa and Omonada districts respectively. But its effect was not statistically significant from the application of other balanced fertilizers. While the shortest plant height (293.4cm and 303.4cm) was recorded from recommended NP treatment which was not statistically significant from other balanced fertilizers at Kersa and Omonada district respectively (Table 1). This increment in plant height might be due to increase in cell elongation and more vegetative growth attributed to different nutrient contents of NPSZnB blended fertilizer. Plant growth and development may be retarded significantly if any of the nutrient elements is less than its threshold value in the soil or not adequately balanced with other nutrient elements (Landon, 1991). This result is also in agreement with that of Dagne (2016), and Tekle and Wassie (2018) who found that application of blended fertilizers and blanket NP recommendation which significantly increased plant height as compared to the control. Likewise, Bakala (2018) found that blended fertilizers had significantly influenced plant height.

Thus the result indicated that blended fertilizers application has enhanced the maize vegetative growth. This result is in agreement with that of Teklu and Wassie (2019) who found that application of blended fertilizers which significantly increased plant height as compared to the control. Asif *et al.*, (2013) has reported that the increase in plant height is due to N and Zn which helps in the production and expansion of more leaf area which results more assimilates production. Similarly more vegetative development by nitrogen resulted in increased mutual shading and intermodal expansion. The result has been confirmed by Masood *et al.*, (2014).

In conformity with the results obtained from this study, plant growth and development may be retarded significantly if any of nutrient elements is less than its threshold value in the soil or not adequately balanced with other nutrient elements (Roy *et al.*, 2006). Thus, the results indicated that balanced fertilizers application has enhanced the maize vegetative growth.

Ear height

The analysis of the variance indicated that application of balanced fertilizer types and Nitrogen rates were not significant. However, numerically the tallest ear height (192cm at Kersa and 184cm at Omonada district) was recorded from 150NPSB + 140 urea top dressed kg ha^{-1} whereas; the shortest ear height (180 cm at Kersa from 200kg/ha of NPSZnB+120kg/ha of urea top dressed and at Omonada 180.8cm from application of 150kg/ha NPSZnB +145 kg/ha urea top dressed) were obtained.

Stem girth

Stem girth of maize was significantly affected ($p<0.05$) by fertilizer treatments (Fig.2). Stem girth of maize significantly differed among the fertilizer treatments. Significantly the highest stem girth (2.52cm) was recorded from the application of recommended NP fertilizer compared to all other treatments, which was also at par with the NPK treatment (2.54cm), while the lowest stem girth was recorded from the control (2.03cm). The significant difference among treatments might be attributed to application of balanced nutrients which enhanced vegetative growth of maize crop and have positive effect on maize stem girth.

The girth of the plant is an important criterion, which determines its strength and ability to resist lodging. The increase in stem girth of maize under balanced fertilization may be due to cell expansion, which induces sturdiness and healthiness of plants, including better root development (Singh and Tripathi, 1979; Ahmed, 1992). These findings were in line with findings of Adamu *et al.*, (2015) who reported that highest stem girth were achieved with application of balanced fertilizers.

Yield and Yield Components

Biomass yield

Biomass yields were significantly higher in all plots treated with blended fertilizers compared to recommended NP fertilizers at both sites (Table 3). In Kersa district the highest biomass yield (15231.3 kg ha^{-1}) was recorded in plots that received blended fertilizers 150NPSZnB kg ha^{-1}+145 urea top dressed. However, in Omonada district amongst the five treatments of blended fertilizers the highest biomass yield (14101.9 kg/ha) was recorded from application of 150NPSB kg/ha +140 urea top dressed had higher yields compared to treatments. The lowest yield (13549.4 kg/ha) was recorded from recommended NP fertilizers. When the biomass yield of both districts compared higher biomass yield was measured at Kersa district this was may be because of continuous vegetative growth of maize crop until the rainfall withdrew. However, in Omonada district low amount of rainfall was rained during the growing seasons as a result the vegetative growing of maize crop was proportionally gone with the received low amount of rainfall. Even though, lowest biomass yields were recorded from recommended NP fertilizers in both study districts there was no consistent increase in yield amongst the different blended fertilizer levels. The current results are in agreement with that of Tamene *et al.*, (2018) who obtained significantly highest biomass yield of maize crop at the rate of 46 kg N ha^{-1} under blended fertilizer of PKSZnB as compared to negative control and recommended NP fertilizers.

Grain yield

The application of blended fertilizer resulted in a highly significant yield influence on the grain yield of maize. The result of experiment indicated that mean grain yield of maize crop was significantly (<0.05) affected by balanced fertilizer rates in both districts (Table 4). In the district of Kersa plots treated with recommended NP fertilizer had significantly lower yield (6449.9 kg ha^{-1}) as compared with other blended fertilizer. But, there was no significant variation amongst the three types of 150NPSB +140 urea, 150 NPSZnB +145 urea and 200NPSZnB + 120 urea kg ha^{-1} blended fertilizer. Accordingly, the highest grain yield (7212.4 kg ha^{-1}) was obtained from application of 150 kg NPSZnB ha^{-1}+145 urea top dressed treatment. In Omonada district significance highest grain yield (6878.4 kg ha^{-1}) was obtained from application of 150 NPSB + 140 urea kg ha^{-1} while the lowest grain yield(6200.8 kg/ha) was obtained from application of recommended NP fertilizer. The increase in grain yield could be attributed to beneficial effect of yield contributing characters and positive interaction of nutrients in the blended fertilizer. Grain yield increment with application of blended fertilizers which contained S, B and Zn indicated that there is a need to supplement these elements for maize production. Dagne (2016) verified that application of blended fertilizer on maize crop as brought significantly highest grain yield as compared to negative control, recommended NP and recommended NP + Cu +Zn. In agreement with the current findings Tekle and Wassie (2018) found that grain yield of tef was found highest in blended fertilizers as compared to control treatment and recommended NP fertilizers. Additionally, Jafer (2018) found that better grain yield maize was obtained from application of blended fertilizer compare to recommended NP fertilizer and unfertilized plot. The increase in grain yield could be attributed to beneficial influence of yield contributing characters and positive interaction of nutrients in the blended fertilizer (Dagne, 2016).

Harvest index

The physiological ability of maize to convert total dry matter in to grain yield is determined by its harvest index (HI). The analysis of variance revealed that balanced fertilizer types and nitrogen rates had highly significantly ($P \leq 0.05$) affected harvest index of maize. At both study locations the application of balanced fertilizers had significant effects on harvest index of maize crop (Fig.4&5). Harvest Index significantly differed for all fertilizer treatments.

Table.1 Effect of balanced fertilizers on plant height (cm) at Kersa and Omonada districts

Treatments	Kersa			Omonada		
	2014/15	2015/16	Over year	2014/15	2015/16	Over year
Rec. NP (92N and 69P_2O_5)	298	287.75	293.44	305.2	301.6[ab]	303.4
150kg/ha NPSB+140kg/ha urea	303	301	302.11	312.2	303.6[ab]	307.9
150kg/ha NPSZnB +145kg/ha urea	305.4	302	304	306.6	310.4[a]	308.5
200kg/ha NPSZnB +120kg/ha urea	310	296.5	304	306	310.2[a]	308.1
200kg/ha NPKSZnB + 140 kg/ha urea	305.8	301.25	303.78	315.4	298.2[b]	306.8
Mean	304.44	297.7	301.44	309.08	304.8	306.94
LSD(0.05)	20.64	16.6	13.39	NS	11.69	NS
CV (%)	5.06	3.62	4.65	4.05	2.86	6.49

Table.2 Effect of blended fertilizers on ear height at Kersa and Omonada districts

Treatments	Kersa			Omonada		
	2014/15	2015/16	Over year	2014/15	2015/16	Over year
Rec. NP (92N and 69P_2O_5)	189[ab]	177.25	184	189.8	177.4	183.6
150kg/ha NPSB+140kg/ha urea	196.8[a]	185	192	196	172	184.0
150kg/ha NPSZnB +145kg/ha urea	183.4[b]	181.75	183	187.8	173.8	180.8
200kg/ha NPSZnB +120kg/ha urea	186[ab]	172.75	180	188.8	178	183.4
200kg/haNPKSZnB+140kg/ha urea	191[ab]	186.75	189	192.2	175.2	183.7
Mean	189.16	180.7	185.4	190.92	175.28	183.1
LSD(0.05)	12.54	16.55	11.77	NS	NS	NS
CV (%)	4.94	5.95	6.64	6.22	4.44	10.28

Table.3 Maize biomass yield (kg/ha) response to balanced fertilizer types and nitrogen rates at Kersa and Omonada districts

Treatments	Kersa			Omonada		
	2014/15	2015/16	Over year	2014/15	2015/16	Over year
Rec. NP (92N and 69P_2O_5)	14126.3	12828.3[b]	13549.4[b]	11529.5[b]	13332.7[b]	12431.1[b]
150kg/ha NPSB+140kg/ha urea	14777.6	14052[ab]	14455.1[ab]	13352.3[a]	14851.6[a]	14101.8[a]
150kg/ha NPSZnB +145kg/ha urea	15522.4	14867.5[a]	15231.3[a]	12029.5[ab]	13374.2[b]	12701.9[b]
200kg/ha NPSZnB +120kg/ha urea	14542.2	14326.5[ab]	14446.3[ab]	12715.9[ab]	15078[a]	13897[a]
200kg/ha NPKSZnB + 140 kg/ha urea	14743.2	13887.8[ab]	14363[ab]	13593.2[a]	13816.8[ab]	13705[a]
Mean	14742.3	13992.4	14409.03	12644.1	14090.7	13367.4
LSD(0.05)	NS	1625.7	1415	1609	1423.5	882.01
CV (%)	7.11	7.54	10.27	9.49	7.53	7.31

Table.4 Effect of balanced fertilizers types and nitrogen rates on grain yield (kg/ha) of maize at Kersa and Omonada districts

Treatments	Kersa			Omonada		
	2014/15	2015/16	Over year	2014/15	2015/16	Over year
Rec. NP (92N and 69P_2O_5)	6189.5	6775.3^{b}	6449.9^{c}	5921.6	6480	6200.8^{b}
150kg/ha NPSB+140kg/ha urea	6758.2	7402.5^{ab}	7044.5^{ab}	6516.3	7240.4	6878.4^{a}
150kg/ha NPSZnB +145kg/ha urea	6614.4	7960^{a}	7212.4^{a}	5705.9	6704.1	6235^{b}
200kg/ha NPSZnB +120kg/ha urea	6666.7	7447.8^{ab}	7013.8^{ab}	6111.1	7271.8	6691.5^{ab}
200kg/haNPKSZnB+140kg/ha urea	6156.9	7286.3^{ab}	6658.8^{bc}	6522.9	6422.6	6472.7^{ab}
Mean	6477.12	7374.35	6875.89	6155.56	6835.78	6495.67
LSD(0.05)	NS	878.45	546.4	NS	NS	608.1
CV (%)	7.51	7.73	8.31	11.12	13.11	10.36

Fig.1 Study area Kersa and Omonada district-Jimma Zone, Oromia National Regional State.

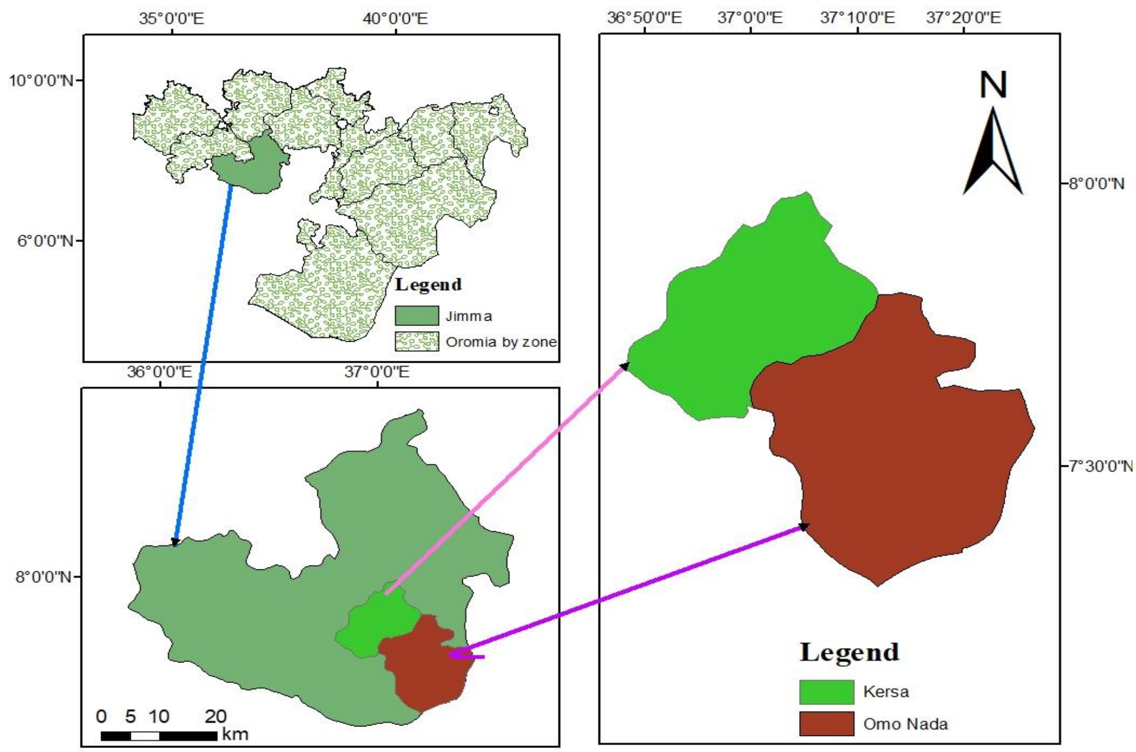


Fig.2 Effect of balanced fertilizers on stem girth of maize at Kersa district.

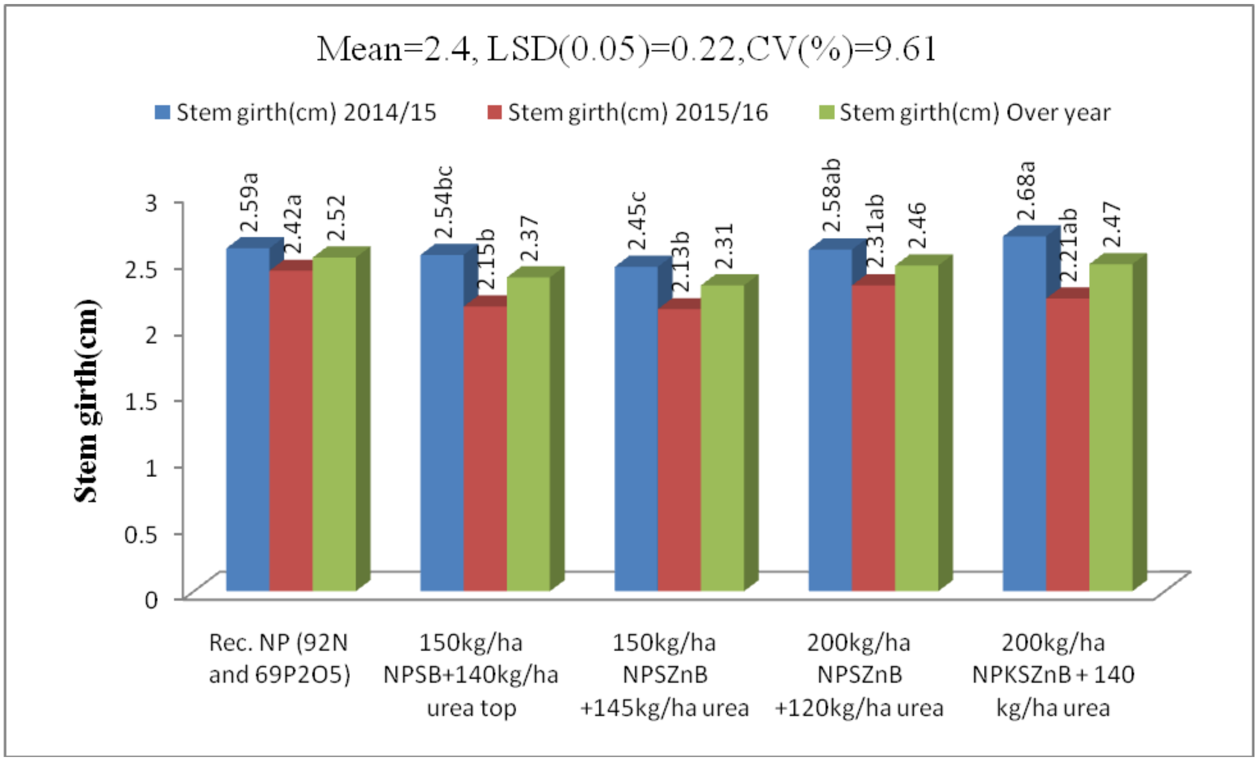


Fig.3 Effect of balanced fertilizers types and Nitrogen rates on stem girth of maize at Omonada district.

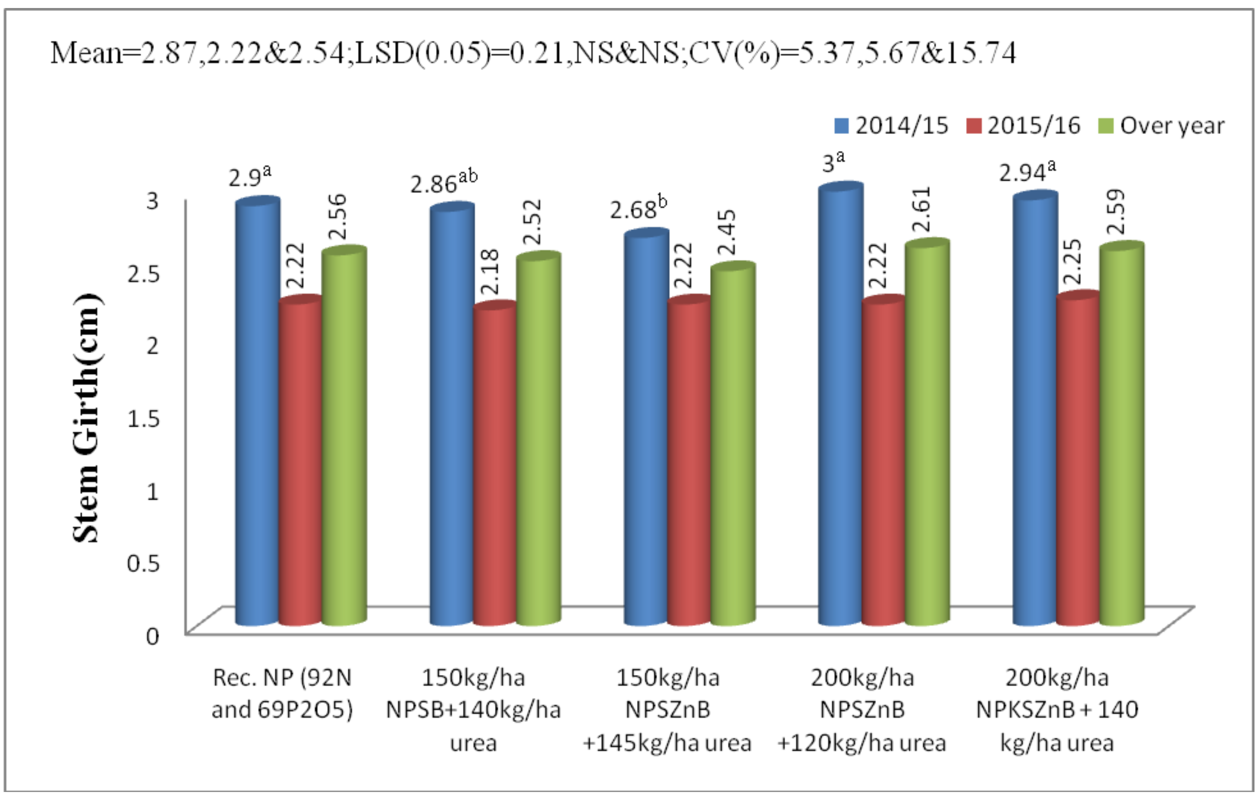


Fig.4 Harvest Index as affected by different blended fertilizers at Kersa district.

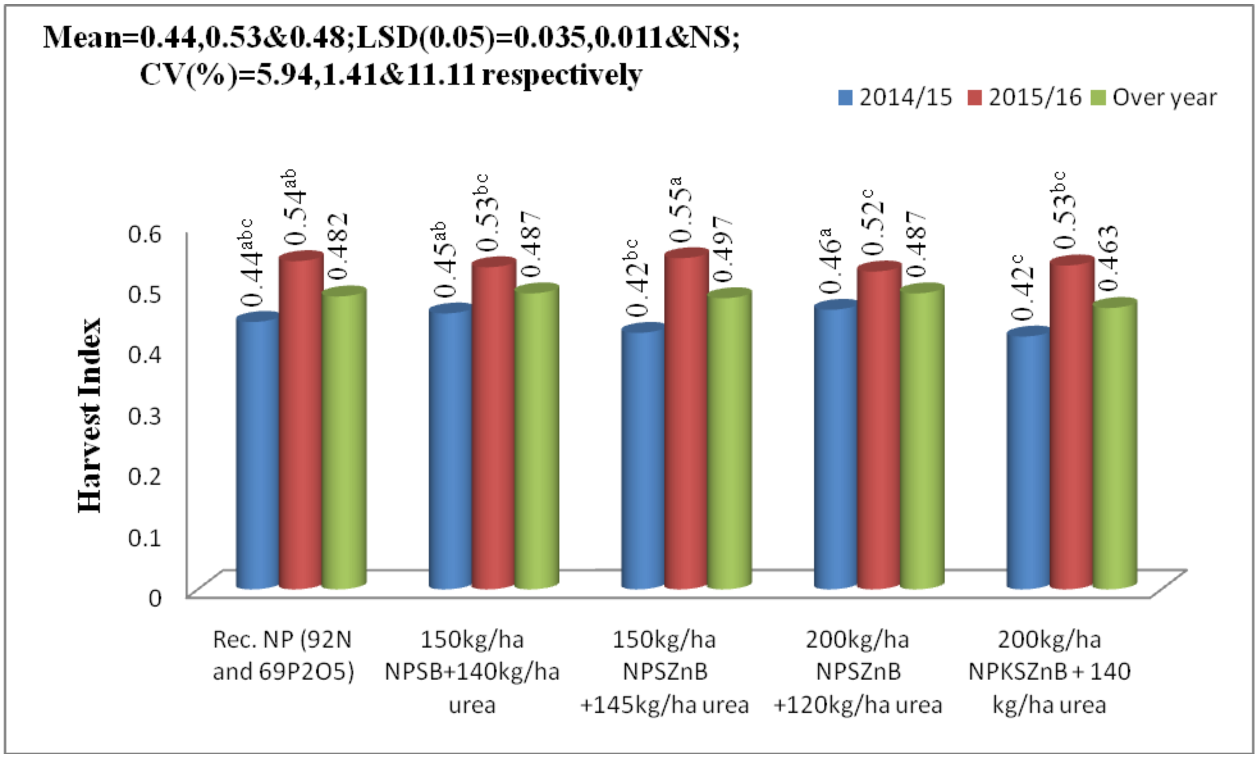
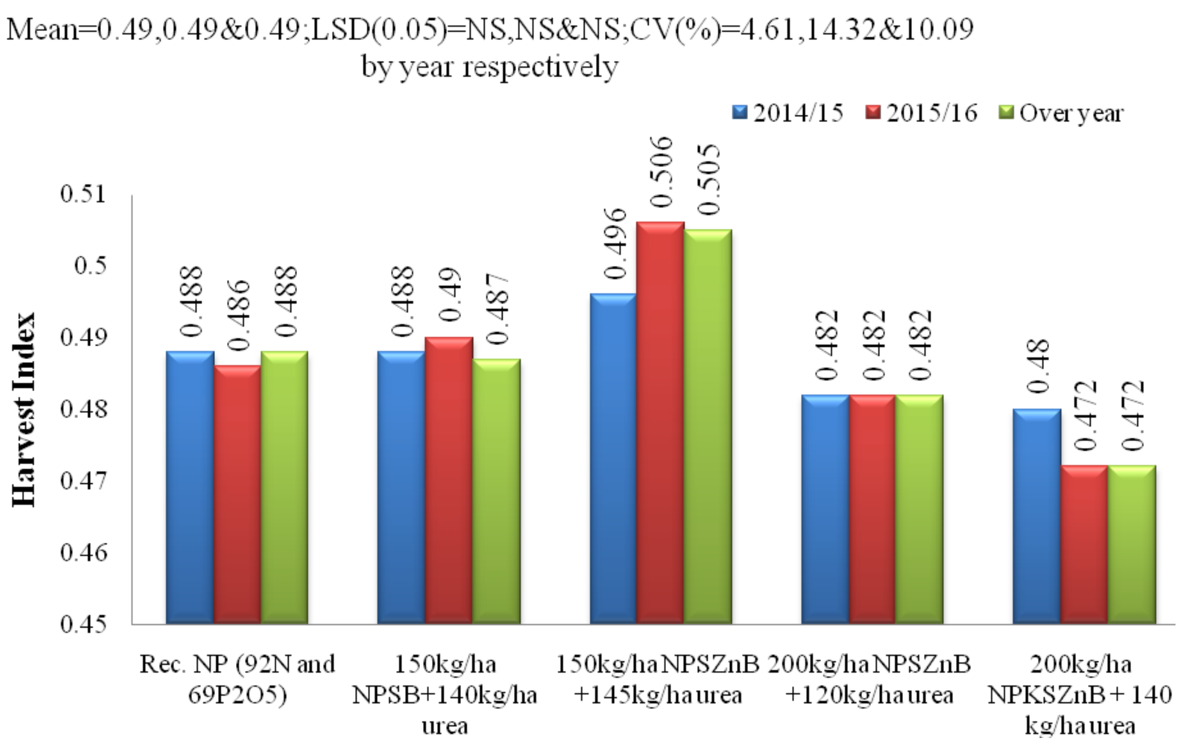


Fig.5 Harvest Index as affected by different blended fertilizers at Omonada district.



Significantly the highest harvest index (0.497) at Kersa and (0.505) at Omonada were obtained by the application of 150 kg/ha NPSZnB+145kg/ha urea top dressed treatment compared to all the other treatments followed by the application of 150kg/ha NPSB + 140kg/ha urea top dressed (0.487), while the lowest harvest index was recorded from the 200kg/ha NPKSZnB + 140kg/ha urea top dressed treatment at both site. The increase in the harvest index due to application of micronutrients may be attributed to their role in enhancing the photosynthesis process and translocation of photosynthetic products to economic part. Generally application of blended fertilizers had significant effects on harvest index of maize crop than recommended NP. This phenomenon has been summarized by Sinclair (1998) that harvest index for crops had increased with grain production dramatically increasing in the twentieth century. Previous studies indicated that harvest index is already close to the practical maximum value around 50% (Katsura *et al.,* 2008); even 55% has been achieved under high-yielding cultivars (Katsura *et al.,* 2008). Similarly, (Hay and Gilbert, 2001) reported that harvest index of maize to be 50% for most tropical maize crops. However, in all treatments, all over the year the harvest index values recorded were below (0.50).

The higher harvest index indicates the proportion of economical yield to total above ground biomass was higher than that of the control treatment. Harvest index obtained were in the acceptable range of 0.4 - 0.6for maize (Hay, 1995). Adequate supply of balanced fertilizers types and nitrogen rates are essential for optimizing partitioning of dry matter between grain and other parts of the maize plant. Optimum utilization of solar radiation, higher assimilates production and its conversion to starch results in higher biomass, grain yield leading to higher harvest index.

The application of blended NPSB fertilizer showed a variation in the parameters like plant height, ear height and biomass yield, grain yield and harvest index of maize crop. This might be due to an increase in cell elongation and more vegetative growth attributed to crop requirements of the blended fertilizer types for its normal physiological growth. Thus, the availability of these nutrients enables the plant to develop a more extensive root system to extract water and nutrients, from more depth. Moreover, it could be attributed to the beneficial effect of yield contributing characters and positive interaction of nutrients in the blended fertilizer. This implies that the application of blended fertilizer as soil fertility management practices from this demonstration confirmed that the necessity of balanced fertilizers types for the improvement of yield and yield component of maize crop and in line with this, Chimdessa (2016) who identified that application of blended fertilizer was significantly improved the weights of the kernels, total above ground dry biomass yield and grain yield when compared with control plots. Similarly, Shiferaw *et al.,* (2018) reported that significantly high grain yield was obtained from the plots treated with NPSB linked to the control treatments.

The harvest index (HI) of a crop is an interaction of its physiological efficiency and its ability to convert the photosynthetic material into economic yield. In general, HI was increased within different balanced fertilizers and nitrogen rates. This report was also slightly similar with (Tekle and Wassie, 2018) those reported the harvest index of maize was found to be significantly higher in plots that received blended fertilizers at rate of 150 kg NPSZnB ha^{-1}.

As a result, all the studied blended fertilizers effect on maize yield and yield components exhibited that blended fertilizers would be promising to grow maize in the study area, whereas maize productivity for the previously existing NP fertilizers in the country was low as compared to the blended fertilizers; which indicated that maize productivity in the study sites was reduced due to high demand for external nutrient inputs rather than NP fertilizers. The results of the study revealed that the maximum mean grain yield (8399.7 kg ha^{-1}) and total biomass yield (16867.7 kg ha^{-1}) were recorded for blended fertilizers, whereas the lowest were recorded from recommended NP fertilizer. Hence, the research results showed that blended fertilizers with different rates of N, P, S, Zn and B might have encouraged the early establishment, rapid growth, and development of crop. To sustain and/or improve the current unbalanced fertilizer application and soil mining of the study sites, precautionary actions such as adopting sustainable soil fertility replenishment strategy, soil conservation practices and avoiding unbalanced fertilizers can help to rebuild the soil conditions to increase crop productivity. Therefore, the use of blended fertilizer for plant nutrient management practices and selecting the most productive varieties of improved maize variety are the most strategic goals for subsistence farmers like the current study area. The research result showed that the rate of 150 kg ha^{-1} NPSZnB and 145kg ha^{-1} urea rate gave the total above ground dry biomass yield, and grain yield of maize. Based on the result of two years field experiment, the plant height, ear height, stem girth, biomass yield, grain yield and harvest index of maize variety (BH-661) was significantly affected by the application of different balanced fertilizer rates. The highest grain and biomass yields of maize were obtained from the application of 150 NPSZnB kg ha^{-1} balanced fertilizer types and 145 urea top dressed. Therefore, as the result of two years experiment it was possible to conclude that, in the presence of appropriate rate of balanced fertilizer types; maize is responsive to high yield at 150 kg NPSZnB ha^{-1} of blended fertilizer. Further researches have to be continued to recommend fertilizer types and rate for the major crops grown in this region.

References

Adamu, U. K., Mrema, J. P. and Msaky, J. J., 2015. Growth response of maize (*Zea mays* L.) to different rates of nitrogen, phosphorus and farm yard manure in Morogoro Urban district, Tanzania. *Am J ExpAgric, 9(2)*: 1-8.

Asif M., Saleem M. F., Anjum S. A., Wahid M. A. and Bilal M. F. 2013.Effect of nitrogen and zinc on growth and yield of maize (*Zea mays* L.). J. Agric. Res., 51(4): 455-464.

Bakala, A., Girma, A. and Sofiya, K., 2018. Soil characterization and response of maize (*Zea mays* L.) to application of blended fertilizer types and rates in Asossa district, Western Ethiopia. *Unpublished MSc Thesis, Haramaya University, Ethiopia.*

Balemi, T., Kebede, M., Abera, T., Hailu, G., Gurmu, G. and Getaneh, F., 2019. Some maize agronomic practices in Ethiopia: A review of research experiences and lessons from agronomic panel survey in Oromia and Amhara regions. African journal of agricultural research, 14(33), pp.1749-1763.

Burke, W. J., Jayne, T. S. and Black, J. R., 2017. Factors explaining the low and variable profitability of fertilizer application to maize in Zambia. Agricultural economics, 48(1), pp.115-126.

Central Statistics Authority (CSA) (2016) Agricultural sample survey 2015/2016. Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Statistical Bulletin No. 584. Addis Ababa, Ethiopia.

Cheruiyot, E. K., Mumera, L. M., Ng'etich, W. K., Hassanali, A. and Wachira, F. N., 2009. High fertilizer rates increase susceptibility of tea to water stress. Journal of Plant Nutrition, 33(1), pp.115-129.

Chianu, J. N., Chianu, J. N. and Mairura, F., 2012.Mineral fertilizers in the farming systems of sub-Saharan Africa. A review. Agronomy for sustainable development, 32(2), pp.545-566.

Chimdessa, D. and Abdeta, A., 2019. Soil Test Crop Response Based Phosphorous Calibration Study on Bread Wheat in Chora District of BunoBedele Zone, West Oromia, Ethiopia. In Regional Review Workshop on Completed Research Activities (p. 54).

Dagne Chimdessa, 2016. Blended Fertilizers Effects on Maize Yield and Yield Components of Western Oromia, Ethiopia. Journal of Agriculture, Forestry and Fisheries. Vol. 5(5):151-162.

Datnoff, L. E., Rodrigues, F. A., Seebold, K. W., 2006. Silicon and plant disease. In: Damoff, L. E., Elmer, W. H., Huber, D. H, (Eds.). Mineral Nutrition and Plant Disease. American Phytopathological Society, St. Paul, MN (in press).

Dercon, S., Gilligan, D.O., Hoddinott, J. and Woldehanna, T., 2009. The impact of agricultural extension and roads on poverty and consumption growth in fifteen Ethiopian villages. American Journal of Agricultural Economics, 91(4), pp.1007-1021.

Drinnan, J. E., 2008. Fertiliser strategies for mechanical tea production. WaggaWagga, NSW, Australia: Rural Industries Research and Development Corporation.

Ezui, K. S., Franke, A. C., Mando, A., Ahiabor, B. D. K., Tetteh, F. M., Sogbedji, J., Janssen, B. H. and Giller, K. E., 2016. Fertiliser requirements for balanced nutrition of cassava across eight locations in West Africa.Field Crops Research, 185, pp.69-78.

Fayera, A, M Muktar and D Adugna, 2014. Effects of different Rates of NPK and Blended Fertilizers on Nutrient Uptake and Use Efficiency of Teff [*Eragrostis tef* (Zuccagni) Trotter] in Dedessa District, Southwestern Ethiopia. J. Biol. Agric Healthcare, 4: 254-258.

Feyissa, A. and Mebrate, M., 1994. Provenance trial of *Cordia africana*. Provenance trials of some exotic and indigenous tree species.Forestry Research Centre, Addis Abeba, pp.81-96.

Gebremeskel, G., Egziabher, Y. G. and Solomon, H., 2017. Response of sorghum (*Sorghum bicolor* (L.) Moench) varieties to blended fertilizer on yield, yield component and nutritional content under irrigation in Raya valley, Northern

Ethiopia. International Journal of Agriculture and Biosciences, 6(3), pp.153-162.

Hay, R. K. M. and R. A. Gilbert, 2001. Variation in the harvest index of tropical maize: evaluation of recent evidence from Mexico and Malawi. Annals of Applied Biology, 138:103.

Hay, R. K. M., 1995. Harvest index: a review of its use in plant breeding and crop physiology. *Annals of applied biology*, *126*(1), pp.197-216.

Jafer Dawid, 2018. Validation of Blended Fertilizer for Maize Production under Limed Condition of Acid Soil Journal of Natural Sciences Research 8 (23): 52 -58.

Jayne, T.S. and Rashid, S., 2013. Input subsidy programs in sub-Saharan Africa: a synthesis of recent evidence. Agric. Econ. 44 (6), 547–562.

Jeet, S., Singh, J. P., Kumar, R., Prasad, R. K., Kumar, P., Kumari, A. and Prakash, P., 2012. Effect of nitrogen and sulphur levels on yield, economics and quality of QPM hybrids under dryland condition of Eastern Uttar Pradesh, India. *Journal of Agricultural Science*, *4*(9), p.31.

Jones, A., Breuning-Madsen, H., Brossard, M., Dampha, A., Deckers, J., Dewitte, O., Gallali, T., Hallett, S., Jones, R., Kilasara, M., Le Roux, P., Micheli, E., Montanarella, L., Spaargaren, O., Thiombiano, L., Van Ranst, E., Yemefack, M., Zougmore, R., 2013. Soil Atlas of Africa. European Commission, Publications Office of the European Union, Luxembourg.

Katsura, K., Maeda, S., Lubis, I., Horie, T., Cao, W. and Shiraiwa, T. 2008. The high yield of irrigated rice in Yunnan, China. Field Crops Research, 107: 1-11.

Khan, F., Khan, S., Fahad, S., Faisal, S., Hussain, S., Ali, S. and Ali, A., 2014. Effect of different levels of nitrogen and phosphorus on the phenology and yield of maize varieties. American Journal of Plant Sciences, 2014.

Kinfe, T., Tsadik, T., Tewolde, B., Weldegebreal, G., Gebresemaeti, K., Solomon, M. and Goitom, A., 2019. Evaluation of NPSZnB fertilizer levels on yield and yield component of maize (*Zea mays* L.) at LaelayAdiyabo and MedebayZana districts, Western Tigray, Ethiopia. Journal of Cereals and Oilseeds, 10(2), pp.54-63.

Kundu, D., Khanam, R., Saha, S., Thingujam, U. and Hazra, G. C., 2017.Boron availability in relation to some important soil chemical properties in acid soils of Cooch Behar district, West Bengal. Journal of Applied and Natural Science, 9(4), pp.2400-2403.

Landon, J. R. 1991. Booker Tropical Soil Manual: a handbook for soil survey and agricultural land evaluation in the tropics and subtropics. (Ed.). John Wiley & Sons Inc., New York.

Marenya, P. P., Barrett, C. B., 2009a. Soil quality and fertilizer use rates among smallholder farmers in western Kenya. Agric. Econ. 40 (5), 561–572.

Masood, Naz T., Javed M., Ahmad I., Ullah H. and Iqbal M. 2014.Effect of short term supply of nitrogen and farm yard manure on maize growth and soil parameters. Archives of agronomy and soil science, 60(3): 337-347.

Matsumoto, T., Yamano, T., 2013.Optimal fertilizer use on maize production in East Africa. In: Yamano, T., Otsuka, K., Place, F. (Eds.), Emerging Development of Agriculture in East Africa: Markets, Soil and Innovations. Springer, New York, NY, pp.117–132.

Montanarella, L., Pennock, D. J., McKenzie, N., Badraoui, M., Chude, V., Baptista, I., Mamo, T., Yemefack, M., Singh Aulakh, M., Yagi, K. and Young Hong, S., 2016. World's soils are under threat. Soil, 2(1), pp.79-82.

Ogundijo, D. S., Adetunji, M. T., Azeez, J. O., Arowolo, T. A., Olla, N. O., Adekunle, A. F. and Borek, S., 2015. Influence of organic and inorganic fertilizers on soil chemical properties and nutrient changes in an alfisol of South Western Nigeria. International Journal of Plant & Soil Science Bangladesh. [Online], 7(62), pp.329-337.

Roy, R. N., Finck, A., Blair, G. J. and Tandon, H. L. S., 2006. Plant nutrition for food security. A guide for integrated nutrient management. FAO Fertilizer and Plant Nutrition Bulletin, 16, p.368.

Saleem M., Gulab K., Gandahi A. W., Bhatti S. M., Velo S., 2016. Efficacy of colemanite ore as boron fertilizer for maize (*Zea mays* L.) growth and yield. Sci. Int.; 28(3):3071–3074.

Sanchez, P. A., Shepherd, K. D., Soule, M. J., Place, F. M., Buresh, R. J., Izac, A. M. N., UzoMokwunye, A., Kwesiga, F. R., Ndiritu, C. G. and Woomer, P. L., 1997. Soil fertility replenishment in Africa: an investment in natural resource capital. Replenishing soil fertility in Africa, 51, pp.1-46.

Sarfaraz Q., Perveen S., Shahab Q., Muhammad D., Bashir S., Ahmed N., Asghar I., 2014. Comparative effect of soil and foliar application of sulfur on maize. J. Agric. Vet. Sci.; 7:32–37.

Shiferaw, B., Mulugeta, H., Atinafu, A. and Abay, A., 2018. Macro and micro nutrients for optimizing maize production at Hawassa Zuria district, southern Ethiopia. *J. Biol. Agri. Health Care*, *8*(7).

Sinclair T R., 1998. Historical changes in harvest index and crop nitrogen accumulation. Crop Science, 38: 638-643.

Tamene, D., Anbessa, B., Legesse, T. A. and Dereje, G., 2018. Refining fertilizer rate recommendation for maize production systems in Assosa, North Western Ethiopia. *Advanced Techniques in Biology and Medicine*, *6*(253), pp.2379-1764.

Tekle, L. and H. Wassie, 2018. Response of tef (*Eragrostis tef* (Zucc.) Trotter) to blended fertilizer in Tembaro, Southern Ethiopia. Journal of Biology, yield component of maize (*Zea mays* L.) at Laelay Agriculture and Healthcare, 8(13): 34-39.

Wako, R. E. and Usmane, I. A., 2020. Evaluation of balanced fertilizer types on yield and yield components of sorghum and validation of soil fertility map based fertilizer recommendation. Journal of Food Science and Nutrition Therapy, 6(1), pp.026-031.

Weldegebriel, R., Araya, T. and Egziabher, Y. G., 2018. Effect of NPK and blended fertilizer application on Yield, Yield Component and its profitability of Sorghum (*Sorghum bicolor* (L.) Moench) varieties under rainfed condition in north western Tigray, Ethiopia. Int. J. of Life Sciences, 6(1), pp.60-68.

Zeng, D., Alwang, J., Norton, G. W., Shiferaw, B., Jaleta, M. and Yirga, C., 2015. Ex post impacts of improved maize varieties on poverty in rural Ethiopia. Agricultural Economics, 46(4), pp.515-526.

How to cite this article:

Obsa Atnafu. 2022. Maize (*Zea mays* L.) Yield Response to the Effect of Balanced Fertilizer Types and N Rates under Rainfed Condition at Kersa and Omonada Districts Jimma Zone, Southwestern Ethiopia. *Int.J.Curr.Res.Aca.Rev.* 10(09), 24-36. doi: https://doi.org/10.20546/ijcrar.2022.1009.004