Determining the Rate of Blended Fertilizers and Urea for Potato Production Under Rain Fed Condition in Kersa Malima, South West Showa, Ethiopia

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Abstract

This experiment was conducted on Belete and Gudenie potato varieties reaction to fertilizer rates Control, 150 kg/ha NPSB+80 kg/ha urea, 250 kg/ha NPSB+80 kg/ha urea, 350 kg/ha NPSB+80 kg/ha urea, 150 kg/ha NPSB+140 urea, 250 kg/ha NPSB+140 kg/ha urea, 350 kg/ha NPSB+140 kg/ha urea, 150 kg/ha NPSB +200 kg/ha urea, 250 kg/ha NPSB +200 kg/ha urea and 350 kg/ha N+200 kg/ha urea in Kersa Malima district in 2018-2019 main cropping seasons (June-August) using completely randomized block design arrangement in three replications. The analysis was done using SAS 9.2. This study revealed that there was highly significant difference among the yield and yield components due to main effect fertilizer rates. The interaction did not affect any parameter considered. The highest total and marketable yield (38.75 t/ha and 36.51 t/ha) respectively were harvested from 350 kg/ha NPSB+140 kg/ha urea followed by total and marketable yield of 250 kg/ha NPSB+200 kg/ha urea (37.57 and 35.66 t/ha), respectively. The partial budget analysis indicated that the highest benefit (108,426.5ETB) was fetched from 350 kg/ha NPSB+140 kg/ha urea followed by 250 kg/ha NPSB+200 kg/ha urea (106,429ETB). But, the marginal rate of return indicated that highest investment return increment of 24,391.25% was recorded from 250 kg/ha NPSB+200 kg/ha urea followed by 150 kg/ha NPSB+80 kg/ha urea (3,004.231%). From this it can be concluded that the NPSB+urea rates highly significantly affected the yield and yield component of potato. It is better to apply 250 kg/ha urea+200 kg/ha urea to potato for high yield and high economic return in Kersa Malima district. It is better to repeat the experiment with more replication and higher rates including planting time as the farmer were planting starting from March.

Keywords: NPSB, urea, yield and yield components, Belete and Gudenie potato varieties

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1. Introduction

Irish potato (Solanum tuberosum L.) is a peak vegetable crop in Ethiopia (Amin, 2018). It is a high potential food security crop for closely populated highland areas (Hirpa et al., 2010). Potato is one of the mostsuiting crops to high lands areas of Ethiopian, which can produce higher yield per unit time and land. In spite of most favorable growing condition in Ethiopia, its average productivity is low when compared with world and other African countries. This is due to cultivation with low or no fertilizer in Ethiopian farmers (Gezu, 2015). As indicated in Chillot and Hassan (2010) the other productivity problem is lower levels of fertilizer use and/or inappropriate type of fertilizers application. Inappropriate soil fertility management is cause of food shortage and malnutrition of tremendous peoples in the country (Gete et al., 2010).

For longer years Ethiopian soil was only added phosphorus and nitrogen fertilizers which found from diammonium phosphate (DAP) and urea in most cases. Recent production strategies and soil tests indicated that shortage of S and B (Asefa et al., 2015) is one of the yield limiting factors. Crop yield decline is a result of inappropriate cropping systems, mono cropping, nutrient mining, unbalanced nutrient application, removal of crop residues and inadequate resupply (Nyamangara et al., 2001). In central and western Ethiopia, soil fertility declining is basic problem of smallholder crop growers (Tolera et al., 2009). Improper cropping system like continuous monocultures of cereals is also contributed ununder mineable contribution to yield reduction and soil nutrients depletion (Zerihun et al., 2013 and Kombiok et al., 2008). According to Fassil and Charle (2009) soil degradation and nutrient depletion have been gradually increasing and increasing; now become a serious problem to agricultural productivity in Ethiopia. Shortage of plant nutrients like N, P, K, S, Zn, B and Cu was observed on major crops in different areas of the country (ATA, 2016). Most Ethiopian soils are deficit in macronutrients (N, P, K and S) and micronutrients (Cu, B, and Zn) (EthioSIS, 2014). This experiment was conducted to determine and recommend the rates of blended fertilizes for potato growers of Kersa Malima districts of Oromia region using Gudenie and Belete potato varieties.
1.1 Materials and Methods

This experiment was conducted comprising Belete and Gudenie potato varieties; and ten fertilizer treatments in Kersa Malima district in 2018-2019 main cropping seasons (June-August) using completely randomized block design arrangement with three replications. The fertilizer treatments were Control, 150 kg/ha blended fertilizer+80 kg/ha urea, 250 kg/ha blended fertilizer+80 kg/ha urea, 350 kg/ha blended fertilizer+80 kg/ha urea, 150 kg/ha blended fertilizer+140 kg/ha urea, 250 kg/ha blended fertilizer+140 kg/ha urea, 350 kg/ha blended fertilizer+140 kg/ha urea, 150 kg/ha blended fertilizer+200 kg/ha urea, 250 kg/ha blended fertilizer+200 kg/ha urea, and 350 kg/ha blended fertilizer+200 kg/ha urea. The blended fertilizers types were NPSB (N=18.9%, P=37.7%, S=6.95%, B=0.1% content) and urea. The soil sample was taken from 0-30cm depth for analysis and the result was found in Table 1.

The land was prepared well by plowing 3-4 times until fine tilth was achieved in similar ways of land preparation rule for potato fields in Holleta research center. Tubers used for planting was similar size for the varieties. The sprouted tubers were planted in 10 cm depth with 75 cm distance between rows and 30 cm between plants on 4.5mx3m plot size. The distance between block was 1.0 m and plot was 0.5 m. All Blended NPSB fertilizer treatments and half amount urea was applied during planting while remaining half of urea applied during start of flowering. All cultural practices except fertilizer treatment was done in the same practice as Holleta research center recommended practice for potato production. Tuber harvesting was done once at proper physiological maturity (70% leaves withering). A tuber dry matter was measured after drying sample biomass in oven dry at 75°C until constant weight had achieved.

1.1.1 Data Collection

During harvesting tubers were categorized into marketable and un-marketable yields. Marketable tubers were tubers which were greater than 20 mm in diameter and free of cracking, diseases, insect and mechanical damage. The tuber dry matter was prepared from 300g sample tubers by drying it in oven at 75°C temperature until constant dry weight was achieved. The data collected were total and marketable tuber number per plot, total tuber and marketable yields in ton/ha, average tuber number/plant and weight/tuber, tuber dry weight in %, plant height and main stem number.

1.1.2 Data Analysis

Data were subjected to analysis of variance using proc GLM (general linear model) procedure of SAS 9.2 software (SAS Institute Inc. 2009). The means were compared with Least Significant Difference (LSD) at 5% significance level and the partial budget analysis was conducted.

1.2 Result

1.2.1 Soil analysis result before planting

The soil had average PH of 6.57, phosphorus ppm of 7.71, total nitrogen of 0.15%, 1.45% organic carbon and CEC (meq/100g), Clay, Silt and sand % tage of 42.55, 34.17, 35.00 and 30.83, respectively. The textural class of soil was generally clay loam.

1.2.2 Plant height

There was highly significant difference among plant heights due to the impact of fertilizer treatments applied (Table 2). The highest plant height (59.76 cm) was recorded at fertilizer application rate of 350 kg/ha NPSB and 200 kg/ha urea even though not significantly different from 350 kg/ha NPSB and 140 kg/ha urea plant height (59.40 cm) while the lowest plant height was registered from control (35.61 cm) (Table 2). Variety was highly significant in affecting plant height (Table 3). Significantly higher plant height (39.53 cm) was obtained from Belete while Gudenie provided lower plant height (37.67 cm) (Table 3). The growing year did not significantly affect plant height (Table 3).

1.2.3 Stem number

The main stem number was not significantly affected by fertilizer rates (Table 2). Both growing year and variety affected main stem number highly significantly (Table 3). The higher 3.48 and 3.34 main stem numbers were observed from 2019 growing year and Gudenie variety, respectively (Table 3).

1.2.4 Dry matter

The tuber dry matter in percent was not significantly affected by fertilizer rates variety and interactions (Table 2). Not significantly different the highest dry matter (24.08%) was observed at control treatment followed by the dry matter (23.74%) of 150 kg/ha NPSB + 200 kg/ha urea; and not significantly different lowest dry matter were observed at 150 kg/ha NPSB + 200 kg/ha urea (23.57%) (Table 2). Tuber dry matter was highly significantly affected by growing year (Table 3). The higher 23.53% tuber dry matter was produced during 2018 growing year while the lower 21.40% was produced during 2019 growing season.

1.2.5 Average tuber number and weight

The average tuber number per plant and weight per tuber were highly significantly affected by the fertilizer rates, variety and growing season (Table 2). The highest average tuber number (12.23 tuber/plant) was recorded from 350 kg/ha NPSB with 140 kg/ha urea followed by 350 kg/ha NPSB with 80 kg/ha urea (11.92 tubers/plant) and
250 kg/ha NPSB with 200 kg/ha urea (11.61 tubers/plant) while the lowest was recorded at control (6.81 tubers/plant) (Table 2). The maximum average tuber weight per tuber (74.52g) was obtained from 350 kg/ha NPSB with 200 kg/ha urea followed by 250 kg/ha NPSB with 200 kg/ha urea (72.91 g), 150 kg/ha NPSB with 200 kg/ha urea (72.25 g) as well as 350 kg/ha NPSB with 140 kg/ha urea (70.26 g) while the lowest (55.82 g) was recorded at control (Table 2). The growing year highly significantly affected both average tuber number and weight (Table 3). The higher average tuber number (12.82 tubers/plant) and the higher average tuber weight (76.46 g) was recorded from 2019 while lowest was from 2018. Variety was highly significant in affecting both average tuber number and weight (Table 3). The higher average tuber number was obtained from Gudenie variety while Belete variety produced higher average tuber weight (72.83g).

1.2 Total and marketable tuber number

The fertilizer treatments, variety and growing season were highly significant in affecting the total and marketable yield (<0.01) (Table 2). The highest marketable tuber number (253, 252.235) were produced by 350 kg/ha NPSB and 140 kg/ha urea followed by 250 kg/ha NPSB and 200 kg/ha urea; and 350 kg/ha NPSB and 200 kg/ha urea while the lowest was recorded at control (123), respectively (Table 2). The higher 302.54 and 265.17 total and marketable tuber numbers were observed during 2019 growing season, respectively. Higher total and marketable tuber number was obtained from Gudenie variety (Table 3).

1.2.7 Total and marketable tuber yield t/ha

The fertilizer treatments, variety and growing year were highly significant in affecting the total and marketable tuber yield (Figure 1, Table 2). The highest total and marketable yield (38.75 t/ha and 36.51 t/ha) were harvested from 350 kg/ha NPSB +140 kg/ha urea followed by total 37.57 t/ha) and marketable yield (35.66) of 250 kg/ha NPSB+200 kg/ha while the lowest total and marketable yield was obtained from control (16.75 t/ha and 15.5 t/ha), respectively (Figure 1). The higher total and marketable tuber yield (44.31 t/ha and 42.13 t/ha) was produced during 2019 growing year, respectively. The higher 34.10 t/ha and 32.09 t/ha total and marketable tuber yield respectively were provided by Belete variety. Increasing NPSB blended fertilizer from 0-150 kg/ha resulted in marketable yield increase of 89.38% while further increase from 150-250 kg/ha and 250-350 kg/ha increase 21.76% and 10.21%, respectively. In other words increasing 0-150, 0-250 and 0-350 kg/ha resulted in marketable yield increase of 89.38%, 111.14% and 121.35%, respectively. On the other hand, increasing urea fertilizer from 0-80 kg/ha resulted in marketable yield increase of 91.85% while further increase from 80-140 kg/ha and 140-200 kg/ha increase 22.00% and 2.32%, respectively. In other words increasing 0-80, 0-140 and 0-200 kg/ha resulted in marketable yield increase of 91.85%, 113.85% and 116.17%, respectively.

The highest benefit (108,426.5TB) was gained from 350 kg/ha NPSB +140 kg/ha urea followed by 250kg/ha NPSB + 200 kg/ha urea (106,429ETB) while the lowest benefit was obtained from control (Table 4). The highest marginal rate of return (24,391.25%) obtained from 250 kg/ha NPSB+200 kg/ha urea (Table 4). This means, the investment return increment rate was highest at application rate of 250 kg/ha NPSB+200 kg/ha urea. At this application the income was 24,391.25% times of the cost of fertilizer and this income was the highest income in relation to the other rates.

1.3 Discussion

The average pH value before planting was general 6.37 which is moderately acidic soil reaction (Herrera, 2005) with pH values ranging 5.69 – 6.98. This pH rage is good for nutrient uptake by the plants (Warren, 2004). The pH value reported for the experimental soil does not have toxicity of aluminum, manganese and hydrogen; rather than abundance of cations like K⁺, Ca²⁺ and Mg²⁺ (Fall, 1998). EthioSIS( 2013) soil pH classification supports the result as it was moderatesoil pH level. The pH of the soil between 5.00 and 7.55 are found within the suitable range for crop Production (Sahlemdhin, 1999). According to FAO (2006) report, pH range of most crops was 4-8 because of variable optimum pH requirement of different crops. Thus, the pH of the experimental soil is almost within the range for productive soils for potato crop. The soil particle size percentage of the soil of production land was 34.17% for clay, 35.00% for silt and 30.83% for sand that forms clay loam soil class. The soil textural class of the experimental site was not far of the ideal soil textural class requirement of potato as it is sandy loam. The available phosphorus content of the growing location soil was 7.15ppm, 6.79ppm, 9.18 for replications I, II, and III respectively and the average was 7.71ppm which were all in general in the low range of available phosphorus according to Tekalign (1991).

The average soil total nitrogen of the site before planting was 0.15% which is in the low range according to rating of Havlin et al. (1999) as rated total nitrogen below 0.1% very low, 0.1 to 0.15 % low, 0.15 to 0.25 % medium, and high > 0.25 %. EthioSIS( 2014) total nitrogen content rating confirms this result was in the low range of nitrogen level.

According to Tekalign (1991) rating the average organic carbon content of the soil before planting was medium as the result indicated 1.45% organic carbon content. Soil organic carbon percentages of < 0.60, 0.6- 1.0, 1.0 - 1.80, 1.80 -3.0, and >3 as very low, low, medium, high and very high, respectively (EthioSIS, 2013). The cation exchange capacity of the experimental area before planting was 42.55 which is a very high cation
There was highly significant difference among plant heights due to the impact of fertilizer treatments applied and variety. The highest plant height (59.76 cm) was recorded at highest fertilizer application rate of 350 kg/ha NPSB and 200 kg/ha urea followed by 350 kg/ha NPSB+140 kg/ha urea (59.04 cm) while the lowest plant height was registered from control (35.61 cm). This is probably due to the crop nutrient need satisfaction and growing condition favorability of growing location that make the crop to take up the applied nutrient and use it for more plant height growth due to applied Boron as it assists the root to absorb more nutrient (Diriba et al., 2019). This result was in agreement with Melkamu et al. (2019) as they reported highest plant height at the highest fertilizer applied. It is also in conformity with Mulugeta et al. (2019). Significantly higher plant height (39.53 cm) was obtained from Belete while Gudenie provided lower plant height (37.67 cm). This is due to genetic potential difference according to Hazelton and Murphy (2007). In line with this, Landon (1991) report also in conformity with the result as he also rated CEC of greater than 40 cmol kg-1 is very high level. From the results, the problem of growing soils of Keresa Malima district was low available phosphorus and nitrogen which require higher application of the plant nutrient to get reasonable yield.

The highest average tuber number and weight, total and marketable number and weight were recorded from the highest fertilizer applied while the lowest were from the control (non-fertilized treatments). These results are in agreement with those of Singh et al. (2016) that reported application of nitrogen, phosphorus and sulfur fertilizer resulted in significantly increased in marketable and total tuber yield. This could be probably due to the fact that tuber number and size increases at higher nitrogen rate because nitrogen can promote the vegetative growth for more photo-assimilate production while phosphorous improved the development of roots for nutrient uptake and stolen for more tuber production. Israel et al. (2012) indicated that increase in nitrogen and phosphorus application from 0 -165 kg/ha and 0 -60 kg/ha were resulted in marketable tuber number increase by 56.36 and 19.2% respectively compared to control. Similarly, Singh et al. (2016) reported that application of 180 kg/ha nitrogen with 50 kg/ha sulfur, increased the number of tuber by 43%. Application of phosphorus fertilizer had significant contribution to increase in total tuber yield and total number of tubers per plant as compared to unfertilized (Rosen and Bierman, 2008). The current result is in consistency with Israel et al. (2012) who reported an increase in total tuber yield and average tuber weight with increased nitrogen and phosphorous fertilizer application. Sulfur fertilizer application is reported for significant increase of potato tuber yield by enlarging tuber sizes (Barczak et al., 2013). According to the report of Mahmoodabad et al. (2010) and Sharma and Arora (1987), increment of nitrogen fertilizer rate resulted in more tuber yield but excessive rate of nitrogen (250 kg ha-1) decreased the total number of tubers per unit area and yield. Similarly, Sharma et al. (2011) reported that application of sulfur fertilizer resulted significant differences on yield and raising the level 0 to 45 kg/ha increased total tuber yield per plant by 32.55%. Also, similar report of response of potato with application of nitrogen and phosphorous fertilizers was mentioned in. Zelalem et al. (2009).

1.4 Conclusion

This study revealed that there was significant difference among the yield and yield components due to fertilizer rates. The interaction did not affect any parameter considered. The highest total and marketable yield (38.75 t/ha and 36.51 t/ha) respectively were harvested from 350 kg/ha NPSB+140 kg/ha urea followed by total and marketable yield of 250 kg/ha NPSB+200 kg/ha urea (37.57 and 35.66 t/ha), respectively. The variety was also highly significant in affecting all parameter considered except total and marketable tuber number as well as average tuber number. The highest benefit (108,426.5TB) was gained from 350 kg/ha NPSB+140 kg/ha urea followed by 250 kg/ha NPSB + 200 kg/ha urea (106,429ETB) while the lowest benefit was obtained from control (Table 4). The highest marginal rate of return (24,391.25%) obtained from 250 kg/ha NPSB+200 kg/ha urea (Table 4). This means, the investment return increment rate was highest at application rate of 250 kg/ha NPSB+200 kg/ha urea. At this application the income was 24,391.25% times of the cost of fertilizer and this income was the highest income in relation to the other rates. From this it can be concluded that the fertilizer rates NPSB+urea highly significantly affected the yield and yield component of potato. It is better to apply 250 kg/ha urea+200 kg/ha urea to potato for high yield and high economic return in Kersa Malima district.

Reference

Amin Ababiya Ababulgu (2018). Integrated Use Of Nps Blended Fertilizer And Cattle Manure On Growth, Yield And Quality Of Potato (Solanum Tuberosum L.) Under Dabo Ghibe Kebele, Seka Werada Of Jimma
Zone, Southwest Ethiopia. M.Sc Thesis
Asiedu, S.K., Astatkie, T. and Yiridoe, E.K. (2003). The Effect of seed-tuber physiological age and cultivar on early potato production. *Journal of Agronomy and Crop Science*, 189:176-184.

Assefa M, Johnson MRS, Nyambilila A, Tekalign M. (2015a). Wheat Response to Applied Nitrogen, Sulfur, and Phosphorus in three Representative Areas of the Central Highlands of Ethiopia -I. *International Journal of Plant 

ATA (Agricultural Transformation Agency) (2016) Soil Fertility Status and Fertilizer Recommendation Atlas of the Southern Nations Nationalities and Peoples’ Regional.

Barczak B, Nowak K, Knapowski T (2013). Potato yield is affected by sulphur form and rate. *Agrochimica* 57(4):363-372.

Chillot Yirga and R.M Hassan. (2010). Social Costes and incentives for optimal control of soil nutrient depletion in the northern highland of Ethiopia. *Agricultural system*, 103:153-160.

Diriba Shiferaw G, et al. (2019). Effects of Blended Fertilizer Rates on Bread Wheat (Triticum Aestivum L.) Varieties on Growth and Yield Attributes. *J Ecol 

EthioSIS (Ethiopian Soil Information System) (2014) Soil Fertility and Fertilizer recommendation Atlas of Tigray Region. Ministry of Agriculture (MoA) and Agricultural Transformation Agency (ATA).

Ethiopian Soil Information System (EthioSIS (2013) towards improved fertilizer recommendations in Ethiopia- Nutrient indices for categorization of fertilizer blends from EthioSIS woreda soil inventory data. Adiss ababa, Ethiopia.

FAO (FOOD AND AGRICULTURE ORGANIZATION). (2006). Plant nutrition for food security .A guide for integrated nutrient management ,Rome, 2006.

Firman D.M and Allen E.J. (2007). *Potato Biology and Biotechnology*, 2007.

Fassil K and Charles Y. (2009) Soil Fertility Status and Numass Fertilizer Recommendation of Typic Haplusterts in the Northern Highlands of Ethiopia. *World Appl Sci J* 6(11): 1473-1480.

Gezu Getachew Debela. (2015). Fertility Mapping of Soils of Bako Tibe District, West Shewa Zone of Oromia National Regional State, Ethiopia. Msc Thesis. Haramaya University, Haramaya.

Gete Zelleke, Getachheu Agegnehu, Dejene Abera and Shahidur Rashid. (2010). Fertilizer and soil fertility potential in Ethiopia Constraints opportunities for enhancing the system.

Center for Africa (ILCA), Addis Ababa, Ethiopia.

Havlin JL, JD Beaton, SL Tisdale, WL Nelson, (1999). Soil fertility and fertilizers: An introduction to nutrient management. Prentice Hall, New York, 499p.

Hazelton P and Murphy B. (2007). Interpreting soil test results. What do all the numbers mean? Pam Hazelton and NSW Department of Natural Resources, 160 p.

Hirpha A, Meuwissen MPM, Tesfaye A, Lommen WJM, Lansink AO, et al. (2010) *Analysis of Seed Potato Systems in Ethiopia*. *American Potato Journal* 87: 537-552.

Israel Z, Ali M and Solomon T. (2012). Effect of different rates of nitrogen and phosphorus on yield and yield components of Potato (Solanum tuberosum L.) at Masha District, southwestern Ethiopia. *International Journal of Soil Science* 7:146-156.

Kombiok JM, Buah SSJ, Segbedji JM (2008) Enhancing Soil Fertility for Cereal Crop Production through Biological Practices and the Integration of In-Organic and In-Organic Fertilizers in Northern Savanna Zone of Ghana. Soil Fertility.

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

Melkamu H.S., Gashaw M., Wassie, H. (2019). Effects of Different Blended Fertilizers on Yield and Yield Components of Food Barley (Hordeum Vulgare L.) on Nitisols at Hulla District, Southern Ethiopia. *Acad. Res. J. Agri. Sci. Res.* 7(1): 49-56.

Mahmoodabad R, Jamaati S, Khayatnezhad M, Gholamin R (2010). Quantitative and qualitative yield of Potato tuber by use of nitrogen fertilizer and plant density. *American-Eurasian journal of Agriculture and Environmental Sciences* 9(3):310-318.

Mulugeta Habte, Atinafu Assefà & Abay Ayalew. (2019). Evaluation of Different Blended Fertilizers Types and Rates for Better Production of Potato at Bule Soil Condition, Southern Ethiopia. *Global Journals 19*(3):1-7.

Nyamangara J, Gotosa J, Mpofu SE (2001) Cattle manure effects on structural stability and water retention capacity of granitic sandy soil in Zimbabwe. *Soil and Tillage Research* 64(3-4): 157-162.

Park, S W, Jeon, J H, Kim, H. S, Hong, S J, Aswath, C, Joung, H. (2009) The effect of size and quality of potato microtubers on quality of seed potatoes in the cultivar ‘Superior’. *Sci Hortic*. 120, 127-129.

Rosen CJ and Bierman PM. (2008). Potato yield and tuber set as affected by phosphorus fertilization. *American Journal of Potato Research* 85(2):110-120.

Sahlemdhin Sertsu (1999) Draft guideline for regional soil testing laboratory. NFIA, Addis Ababa, Ethiopia.

Singh H, Madhu S, Aakash G, Monika B. (2016). Effect of Nitrogen and Sulphur on Growth and Yield
Attributes of Potato (Solanum tuberosum L.). International Journal of Plant and Soil Science 9(5):1-8.
Sharma DK, Kushwah SS, Nema PK, Rathore SS. (2011). Effect of sulphur on yield and quality of Potato (Solanum tuberosum L.). International Journal of Agricultural Research 6(2):143-148.
Sharma VC and Arora BR. (1987). Effects of nitrogen, phosphorus, and potassium application on the yield of potato (Solanum tuberosum L.) tubers. Journal of Agricultural Sciences 108:321-329.
Tekalign Tadesse, (1991). Soil, plant, water, fertilizer, animal manure and compost analysis. Working Document No 13. International Livestock Research Center for Africa (ILCA), Addis Ababa. Kjedahl Jackson, M.L. 1958.
Tolera A, Feyisa D, Friesen DK. (2009) Effects of Crop Rotation and N-P Fertilizer Rate on Grain Yield and Related Characteristics of Maize.
Zelalem A, Takalign T, Nigussie D. (2009). Response of potato (Solanum tuberosum L.) to different rate of nitrogen and phosphorus fertilization on vertisols at Debre Birhan, in the central highlands of Ethiopia. African Journal of Plant Science 3:16-24.
Zerihun A, Sharma JJ, Nigussie D, Fred K. (2013) The effect of integrated organic and inorganic fertilizer rates on performances of soybean and maize component crops of a soybean/maize mixture at Bako, Western Ethiopia. Afr J Agric Res 8: 3921-3929.

Table 1: Soil analysis before planting for the growing location

| Replication | PH | Avi. P ppm | N (%) OC | CEC (meq/100g) | Texture % |
|-------------|-----|------------|---------|----------------|-----------|
|             |     |            |         |                | Clay | Silt | Sand |
| 1           | 6.73 | 7.15 | 0.13 | 1.26 | 41.92 | 35 | 35 | 30 |
| 2           | 6.63 | 6.79 | 0.20 | 1.18 | 43.42 | 35 | 37 | 27.5 |
| 3           | 6.22 | 9.18 | 0.13 | 1.92 | 42.3  | 32.5 | 32.5 | 35 |
| Average     | 6.53 | 7.71 | 0.15 | 1.45 | 42.55 | 34.17 | 35.00 | 30.83 |

Available phosphorus in parts per mole, total nitrogen in percentage, Organic matter in percentage, Cation exchange capacity in meq per 100g.

Table 2: Effect of NPSB and Urea fertilizers on potato dry matter, height, stem number, yield and yield component

| NPSB + Urea kg/ha | PH(cm) | SN | DM % | ATN/plant | ATW/tuber in g | MTN/plot | TTN/plot |
|-------------------|--------|----|------|------------|----------------|-----------|----------|
| 350+200           | 59.76a | 4.78a | 23.48 | 10.82cde | 74.52a | 235ab | 283bcd |
| 350+140           | 59.40ab | 4.57a | 23.44 | 12.23a | 70.26abc | 253a | 287abc |
| 350+80            | 49.71f | 4.43a | 23.48 | 11.92ab | 65.00def | 233b | 280bcd |
| 250+200           | 53.20de | 4.42a | 23.57 | 11.61abc | 72.91ab | 252a | 297ab |
| 250+140           | 55.93cd | 4.75a | 23.74 | 10.40de | 72.25ab | 212c | 264de |
| 250+80            | 56.60bc | 4.42a | 23.37 | 11.21bcd | 69.60bcd | 233b | 280bcd |
| 250+140           | 51.51ef | 4.67a | 23.34 | 11.04bcd | 63.03ef | 223bc | 276de |
| 250+80            | 56.03cd | 4.76a | 22.97 | 10.49de | 67.50cde | 219bc | 267de |
| 150+140           | 53.53de | 4.65a | 23.14 | 9.98e  | 62.74f  | 206c | 258e |
| Control           | 35.61g | 3.75b | 24.08 | 6.81f  | 55.82g  | 123d | 159f |

LSD 2.8934 0.3751 0.90 4.69 19.00 20.00

P-value <.0001 <.0001 NS <.0001 <.0001 <.0001 <.0001

PH (cm) = plant height in cm, SN = stem number, DM % = tuber dry matter in percent, ATN/plant = Average tuber number per plant, ATW/tuber(g) = Average tuber number per tuber in g, TTN/plot = Total tuber number per plot, MTN/plot = Marketable tuber number per plot.
Table 3: Effect of year and variety on potato dry matter, height, stems number, yield and yield Component

| Year | PH(cm) | SN | DM (%) | ATN/ plant | ATW/ tuber | MTN/ plot | TTN/ plot | TTY t/ha | MTY t/ha |
|------|--------|----|--------|------------|------------|------------|------------|----------|----------|
| 2018 | 42.25b | 3.72b | 23.53a | 8.48b | 55.27b | 172.32b | 232.66b | 29.73b | 18.50b |
| 2019 | 64.00a | 5.32a | 21.40b | 12.82a | 79.46a | 265.17a | 302.54a | 44.13a | 42.44a |

LSD 1.29 0.17 0.33 0.40 2.10 8.60 9.14 1.30 1.29

P-value <.0001 <.0001 <.0001 <.0001 <.0001 <.0001 <.0001 0.002 <.0001

Variety

| Variety | Belete | Gudenie |
|---------|--------|---------|
| PH(cm) | 54.56a | 51.70b |
| SN | 4.18b | 4.86a |
| DM % | 23.56 | 23.36 |
| ATN/ plant | 10.35b | 10.95a |
| ATW/ tuber | 72.83a | 61.90b |
| MTN/ plot | 210.93b | 226.56a |
| TTN/ plot | 254.94b | 302.54a |
| TTY t/ha | 34.10a | 44.13a |
| MTY t/ha | 32.09a | 28.85b |

LSD 1.29 0.17 0.40 2.10 8.60 9.14 1.30 1.29

CV 11.73 17.87 6.71 18.13 15.00 18.93 16.45 19.32 20.35

P-value <.0001 <.0001 NS 0.0032 0.0004 <.0001 <.0001 <.0001 <.0001

PH (cm)=plant height in cm, SN=stem number, DM %= t uber dry matter in percent, ATN/plant= Average tube r number per plant, ATW/tuber(g)= Average tuber number per tuber in g, TTN/plot= Total tuber number per plot, MTN/plot=Marketable tuber number per plot, TTY t/ha= Total tuber yield ton per hectare, MTY t/ha= marketable tuber number ton per hectare.

Table 4: Partial Budget analysis

| Fertilizer rates | Variable cost ETB | Marginal cost ETB | Gross benefit ETB | Net ETB | Benefit | Marginal Benefit | Marginal rate of return % |
|------------------|-------------------|------------------|-------------------|---------|---------|------------------|-------------------------|
| NPSB+Urea kg/ha  |                   |                  |                   |         |         |                  |                         |
| control          | 0                 |                  | 48,825            | 48,825  |         |                  |                         |
| 150+80           | 1170              | 1170             | 85,144.5          | 83,974.5| 35,149.5| 3,004.231        |                         |
| 150+140          | 1890              | 720              | 94,626            | 92,736  | 8,761.5 | 1,216.875        |                         |
| 150+200          | 2610              | 720              | 97,618.5          | 95,008.5| 2,272.5 | 315.625          |                         |
| 250+80           | 4460              | 1850             | 93,334.5          | 88,874.5| 9,549   | 1,326.25         |                         |
| 250+140          | 5180              | 720              | 103,603.5         | 98,423.5| 9,549   | 1,326.25         |                         |
| 250+200          | 5860              | 680              | 102,532.5         | 96,672.5| 9,756.5 | 24,391.25        |                         |
| 350+80           | 5900              | 40               | 112,329           | 106,429 | 9,756.5 | 24,391.25        |                         |
| 350+140          | 6580              | 680              | 115,006.5         | 108,426.5| 9,997.5 | 293.75           |                         |
| 350+200          | 7300              | 720              | 106,690.5         | 99,390.5|         |                  |                         |

Price for 100kg potato was 400ETB and yield adjustment factor 10%

Figure 2: Effect of NPSB +Urea kg/ha on Total and marketable tuber yield at Kersa Malima Growing condition