

# Effects of Blended NPS Fertilizer Rates on Yield and Yield Components of Potato (*Solanum tuberosum* L.) Varieties at Dessie Zuria District, Ethiopia

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## Abstract

In Ethiopia, the average yield of potato is far below the potential due to different problems like in appropriate agronomic practices. Hence, this research was done to evaluate the effects of NPS fertilizer rates on yield and yield components of potato. The study was conducted at Dessie Zuria district, Ethiopia during dry season of 2015. A factorial combination of six level of NPS fertilizer (0:0:0, 111:89.7:0, 111:89.7:16.52, 55:89.7:16.52, 111:44.85:8.26 and 55:44.85, 8.26) kg ha<sup>-1</sup> and two potato varieties were plotted in Randomized Complete Block Design with three replications. The highest plant height of potato (87.60 cm) was recorded on 111: 89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer rate. Belete variety supplied with 111: 89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer rate recorded the maximum days (124.3) to maturity of potato. Similarly, Belete variety recorded the higher biomass than local variety. The 111:89.7:16.52 kg ha<sup>-1</sup> and 55.5:89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer rates showed the highest aboveground biomass (103.24 g hill<sup>-1</sup>) and underground biomass of potato (290.9 g hill<sup>-1</sup>) respectively. The highest average tuber number per hill (15.67), tuber weight per hill (1.82 kg), marketable (53.61 t ha<sup>-1</sup>), unmarketable (0.542 t ha<sup>-1</sup>) and total (54.15t ha<sup>-1</sup>) tuber yield were recorded on potato which was applied with 55.5: 89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer rate. In all characteristics of growth and yield of potato, Belete variety was better than local variety. Similarly, potato fertilized with 55.5: 89.7:16.52 kg ha<sup>-1</sup>of NPS fertilizer rate was showed highest yield than other rates.

**Keywords:** Potato; fertilizer rates; variety; marketable yield; tuber yield

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## 1. Introduction

Potato (*Solanum tuberosum* L.) belongs to the family Solanaceae and genus Solanum (Thompson and Kelly, 1972). It is the major world food crops in its ability to produce high volume food per unit area and time (Israel et al., 2012). With the annual production of the world and Africa in the year of 2017 was about 388, 190, 674 and 25,011,823 tons respectively (FAOSTAT, 2019).

In Ethiopia, potato is one among the most economically important crops as a source of food and cash in the country (Adane, 2010). Potato production in Ethiopia has increased from 349,000 tons in 1993 to around 932,701 tons in 2017 (FAOSTAT, 2019) and can potentially be grown on about 70% of arable land in the country (CSA, 2008/2009). However, the current area cropped with potato (about 160,000 ha) is small and the average yield (less than 10 tons ha<sup>-1</sup>) which is far below the potential of the crop (Adane, 2010). Inappropriate agronomic practices, shortage of seed tubers of improved potato varieties, soil nutrient depletion, moisture stresses, diseases and insect pests are the major constraints of potato production in the country (Tekalign and Hammes, 2005, Kefelegn *et al.* 2012)

The status of horticultural crops development including potato especially in the Northeast Ethiopia is negligible and mostly produced traditionally. However, with establishment and expansion of small scale irrigation schemes, the production of horticultural crops including potato is progressing, and yet the system of the production is constrained by various factors like lack of fertilizer (Alemu, 2014). Depletion of soil nutrient resulted from continuous cropping and/or low inherent soil fertility status; limited application of organic and inorganic nutrient sources fertilizers, leaching/erosion are some of the most important constraints limiting potato production in Eastern Africa including Ethiopia (Linus and Irungu, 2004). The national yield and variety trials data over several locations on different crop species clearly indicated that soil nutrient stress is the most significant factor controlling potato yield in Ethiopia.

Ethiopian farmers primarily rely on only two fertilizer types to supplement the nutrient requirement of the crops. Farmers are currently using 195 kg ha<sup>-1</sup> of di-ammonium phosphate (DAP) and 165 kg ha<sup>-1</sup> of urea to satisfy the phosphorous and nitrogen requirements of potato respectively throughout the country without considering the fertility status of the soil, the environment and the type of varieties used (Tewodros, 2014). But the Ethiopian soils

lack most of the macro and micronutrients that are required to sustain optimal growth and development of crops (Shiferaw, 2014). Consequently, the yield and productivity of crops including potato in Ethiopia are much lower than other countries.

To alleviate the problem, the Ministry of Agriculture of Ethiopia has introduced a new blended fertilizer which contains nitrogen, phosphorous and sulfur (NPS) with the ratio of 19% N, 38% P<sub>2</sub>O<sub>5</sub> and 7% S. This fertilizer has been currently distributed in Ethiopian crop production system (Ministry of Agriculture and Natural Resource (MoANR, 2013). However the situation is challenging for the researchers and smallholder farmers to understand the effects and the optimum rates of the newly introduced blended NPS fertilizer that contains sulfur for production of crops including potato. Therefore, the objective of this study is to evaluate the effects of different rates of NPS fertilizer on yield and yield components of potato in Abaso Kotu, Dessie Zuria district, Northeast Ethiopia.

## 2. Materials and methods

### 2.1. Description of the Study Area

The experiment was conducted on farmers' training center of Abaso Kotu peasant association, Dessie Zuria district, northeast, Ethiopia. The experimental site is located at 039°30'22.7'' E, and 11°05'30.8'' N at an elevation of 2270 m.a.s.l. The average annual minimum and maximum temperatures of the district is about 10°C and 25°C, respectively. The annual average rainfall of the district ranges 900-1100mm with bimodal distribution and the soil of the site is sandy loam.

### 2.2. Experimental materials, treatments and design

The experiment was consisted of six NPS(0:0:0, 111:89.7:0, 111:89.7:16.52, 55.5: 89.7:16.52, 111:44.85:8.26, 55.5:44.85:8.26) fertilizer rates taken on the basis of the N and P<sub>2</sub>O<sub>5</sub> fertilizer application rate of recommended 195 kg ha<sup>-1</sup>Diammonium Phosphate (DAP) and 165 kg ha<sup>-1</sup> urea for major potato producing area of Ethiopia (Agajie et al., 2007). Two potato varieties (Local and Belete) used as planting material. The experimental plots were laid out as a randomized complete block design (RCBD) in factorial arrangements with three replications. Each plot was 3 meter wide and 3 meter long with 1m and 1.5m spacing between plots and blocks respectively. Each plot contained 4 rows with 10 plants per row. Medium sized, healthy and well-sprouted potato tubers were planted at the spacing of 30 x 75 cm.

### 2.3. Management of the experimental plots

The experimental site was prepared using draft animals and human labor. Soil sample was taken randomly from five spots of the experimental area diagonally at the depth of 30 cm before planting and mixed to make a composite. The collected samples were air-dried and grounded to pass through 2mm sieve for analysis of physical and chemical properties. The pH of the soil was determined by diluting the soil with water in 1:2.5 ratios by using pH meter whereas electrical conductivity was measured by a conductivity meter (Van Reeuwijk, 1992). The organic carbon was determined by oxidizing the carbon under standard conditions with potassium dichromate in sulfuric acid solution (Walkley and Black, 1934). Finally, the organic matter content of the soil was calculated by multiplying the organic carbon percentage by 1.724. The total nitrogen content in soils was determined using the Kjeldahl procedure (Horneck et al., 2011). Available phosphorous and Exchangeable bases (K and Na) were determined by Olsen (1954) and Rowell (1994) methods respectively. Salinity of the sample soils was measured as electrical conductivity (EC) and expressed in decisiemens (ds/m) (Rhoades et al., 2002). Particle size (soil texture) was determined by using hydrometer method of Bouyoucos (Day, 1965). First irrigation was given just after planting and subsequent irrigations were given when required. Weeding was done manually whenever needed. Earthing-up was done twice which promotes stolon production that develops in to tubers. There was no major diseases and pests' incidence encountered.

### 2.4. Method of data collection and analysis

Both the growth and yield parameters were collected from 6.075 m<sup>2</sup>of the net plot area. The collected parameters were plant height (cm), number of stems per hill, days to 50% flowering, days to physiological maturity, Above ground biomass (g hill<sup>-1</sup>), below ground biomass (g hill<sup>-1</sup>), total biomass (g hill<sup>-1</sup>), tuber numbers per hill, average tuber weight (kg hill<sup>-1</sup>), unmarketable tuber yield (t ha<sup>-1</sup>), marketable tuber yield (t ha<sup>-1</sup>) and tuber yield (t ha<sup>-1</sup>). The collected data were subjected to the analysis of variance (ANOVA) by using SAS (Statistical Analysis System) version 9.0.1. The least significant difference (LSD) test at 5% probability was used for mean separation of the treatments.

## 3. Results

### 3.1. Soil Properties before Planting

The physical and chemical properties of the soil of the experimental field are indicated in Table 1. The soil textural class of the experimental site is Sandy loam. The soil of experimental field is slightly acidic in pH (6.8), slightly

saline in electrical conductivity (4.45ds/m), very low in organic sulfur (0.0114%), high organic carbon (1.326%), very high organic matter (2.286%), low in total N (0.1143%), Extremely low in available phosphorus (11.18 ppm) and high in Exchangeable K (1.242meq/100g) ions. From the results of soil analysis it can be depicted all sulfur, nitrogen and phosphorus may be yield limiting for potato production in the area.

Table 1:-

### 3.2. Phonological and Growth components of potato

#### Plant height and Stem number per hill

Varieties had no significant effect on plant height but fertilizer rates showed significant effect at ( $p \leq 0.05$ ). Accordingly, the highest plant height of potato (87.60 cm) was recorded on fertilizer rate of 111: 89.7:16.52kg ha<sup>-1</sup> of NPS while the shortest plant height (62.27cm) was recorded on plants where no fertilizer was applied. On the other hand, both the interaction and the main effect of variety and fertilizer rate showed statistically non-significant variation on stem number per hill ( $p \leq 0.05$ ) (Table 2). Despite the fact that stem density is one of the most important yield components in potato, the results of the present study showed that the influences of variety and fertilizer rates on stem number were non-significant.

#### Days to flowering

Varieties had significant effect ( $p \leq 0.05$ ) on days to 50% flowering but not fertilizer rates. The longer (59.17) days to 50% flowering of potato was recorded on Belete than local variety. This may be due to differences in genetic makeup of the two varieties (Table 2).

Table 2:-

#### Days to maturity

The analysis of variance revealed that there was significant interaction effect between variety and NPS fertilizer rate on days to physiological maturity of potato. The maximum days (124.3) to physiological maturity of potato was recorded on Belete variety supplied with 111: 89.7:16.52kg ha<sup>-1</sup> of NPS fertilizer rate. But the shortest days to physiological maturity (111) was recorded on Belete variety in the absence of fertilizer application but not significant difference with Belete variety treated with 111:89.7:0 fertilizer rate and local variety treated with 55.5: 44.85:8.26, 111:44.85:8.26 fertilizer rates and untreated with fertilizer (Table 3).

Table 3:-

### 3.3. Yield and Yield Components of Potato

#### Above ground, below ground and total biomass

The higher aboveground biomass (91.8 g hill<sup>-1</sup>), underground biomass (261.2 g hill<sup>-1</sup>) and total biomass (352.9g hill<sup>-1</sup>) were recorded on Belete variety. In the case of fertilizer rates, the highest above ground biomass (103.24 g hill<sup>-1</sup>) was recorded on potato plants which were fertilized with 111:89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer rate. While the highest underground biomass of potato (290.9 g hill<sup>-1</sup>) was recorded on potato fertilized with 55.5:89.7:16.52 kg ha<sup>-1</sup> NPS fertilizer treatment, but not significant difference with potato fertilized with 111:89.7:0, 111:89.7:16.52 and 55.5:44.85:8.26 kg ha<sup>-1</sup> of NPS fertilizer rates. Similarly, the highest total biomass (378.8 g hill<sup>-1</sup>) was recorded on potato plants which were fertilized with 55.5: 89.7:16.52 kg ha<sup>-1</sup> of NPS but not significant difference with potato fertilized with 111:89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer rate. The lowest aboveground biomass (45.60 g hill<sup>-1</sup>), underground biomass (171.1g hill<sup>-1</sup>) and total biomass (216.7 g hill<sup>-1</sup>) were recorded potato plants with nil fertilizer application.

Table 4:-

#### Average tuber number per hill

The analysis of variance revealed that there was no significant difference between varieties in their average tuber number per hill. However, the fertilizer rates affected the tuber number significantly. The highest average tuber number per hill (15.67) was recorded on potato which was applied with 55.5: 89.7:16.52 kg ha<sup>-1</sup> of NPS but not significant different with all NPS fertilizer rates applied to potato plants while the untreated with NPS fertilizer potato plants recorded the lowest tuber number per hill (Table 4).

#### Average tuber weight per hill

The analysis of variance revealed that both variety and NPS fertilizer rates affected the tuber weight per hill of potato. The higher tuber weight per hill (1.606 kg) was recorded on Belete variety than local variety. On the other hand, potato which was supplied with 55.5: 89.7:16.52 kg ha<sup>-1</sup> NPS fertilizer rate scored the highest (1.82 kg hill<sup>-1</sup>) tuber weight per hill but not significant difference with 55.5:89.7:16.52, 111:44.85:8.26 and 55.5:44.85:8.26 kg ha<sup>-1</sup> of NPS fertilizer rates. The lowest tuber weight per hill (1.123 kg hill<sup>-1</sup>) was recorded on unfertilized potato but not significant difference with potato fertilized with 111:89.7:0 kg ha<sup>-1</sup> NPS rate (Table 5).

Table 5:-

#### Tuber Yield of Potato

The variety and NPS fertilizer rates showed significant difference ( $p \leq 0.05$ ) on marketable, unmarketable and total tuber yield of potato. All the higher marketable (48.11 t ha<sup>-1</sup>), unmarketable (0.501 t ha<sup>-1</sup>) and total (48.6t ha<sup>-1</sup>)

tuber yield of potato were obtained from Belete variety compared to the local variety. Similarly, the highest marketable ( $53.61 \text{ t ha}^{-1}$ ), unmarketable ( $0.542 \text{ t ha}^{-1}$ ) and total ( $54.15 \text{ t ha}^{-1}$ ) tuber yield were obtained from potato which were supplied with  $55.5: 89.7:16.52 \text{ kg ha}^{-1}$  of NPS fertilizer rate but not significant difference with potato supplied with  $111: 89.7:0$ ,  $111: 89.7:16.52$  and  $55.5: 44.85:8.26 \text{ kg ha}^{-1}$  of NPS fertilizer rates. While the lowest marketable ( $31.5 \text{ t ha}^{-1}$ ), unmarketable ( $0.358 \text{ t ha}^{-1}$ ) and total ( $31.85 \text{ t ha}^{-1}$ ) tuber yields of potato were obtained from potato which were not supplied by NPS fertilizer (Table 5).

#### 4. Discussion

##### Plant height and Stem number per hill

The potato plant height was significantly affected by NPS fertilizer rates which correlate with the finding of Alemayehu and Jemberie, 2018. The increased potato plant height by application of NPS may be attributed by physiological stem elongation effect of nitrogen which is also observed by other authors (Lamessa and Zewdu, 2016; Sriom, 2017). Similarly, Yohannes (1994) who reported significant increment in plant height of enset crops as the rates of N and P applications were increased. The effects of nitrogen on plant height seemed to be enhanced due to the presence of PS. This may be due to the fact that these three important plant nutrients have interrelated metabolic and physiological functions in the plants. Thus, it is possible to conclude from the present observation that P and S are helpful in amplifying the effects of N on plant height. Also, the increase in growth parameters under sulphur application might be due to improved sulphur availability, which in turn enhanced the plant metabolism and photosynthetic activity resulting into better growth. These findings are in agreement with Singh and Shrivastava, 1995 and Jat *et al.* (2013). The increased plant heights have been also reported on wheat and garlic by application of NPS fertilizer (Abera *et al.*, 2018 and Yayeh *et al.*, 2017).

Despite the fact that stem density is one of the most important yield components in potato, the results of the present study showed that the influences of variety and fertilizer rates on stem number were not significant difference. This could be due to the fact that stem number is determined very early in the ontogeny of yield (Lynch and Tai, 1989). It could also be due to the case that this trait was not influenced much by the mineral nutrition, as the stem number is the reflection of storage condition (Allen, 1978), physiological age of the seed tuber (Lynch and Tai, 1989; De La Morena *et al.*, 1994) and tuber size (Harris, 1978).

##### Days to flowering and maturity

The effects of NPS fertilizer rates was not significant difference on days to 50% flowering which is not in line with the findings of Alemayehu and Jemberie (2018), Lauer (1986) and Ojala *et al.* (1990) who observed an excessive vegetative growth and thus delayed flowering of potato with high level of nitrogen fertilizer. Nitrogen fertilizer increased the leaf area which increases the amount of solar radiation intercepted and consequently, increases days to flowering, days to physiological maturity, plant height and dry matter production of different plant parts (Krshnappa, 1989). In contrast to nitrogen effect, increasing phosphorous application shortened the time required to attain flowering stage of potato plants because phosphorus possesses a very useful effect on cell division and albumen formation, flowering and fruiting including seed formation and crop maturation (FAO, 1984) and stunting of growth (Brady and Weil, 2002). Also, sulfur has role in better partitioning of the photosynthates in the shoot and tubers (Sud and Sharma, 2002). Hence, the reason for non-significance difference on days to flowering between fertilizer rates in this study might be due to the counteract of phosphorus and sulfur on the effect of nitrogen. But in days to physiological maturity the interaction effect between variety and NPS fertilizer rate was significantly different. The maximum days to physiological maturity was recorded on Belete variety supplied with the maximum NPS fertilizer rate while the shortest days to maturity was recorded on the unfertilized potato plant of same variety. This finding is supported with the results of Abera *et al.* (2018), Alemayehu and Jemberie, (2018), Wilcox and Hoff, (1970), Kleinkopf *et al.* (1987) and FAO, (1984).

##### Above ground, below ground and total biomass

The above ground biomass, below ground biomass and total biomass of the potato were significantly affected by the main effects of NPS rate and variety. The result of this study revealed that, the above ground biomass, below ground biomass and total biomass were higher in potato plants which were supplied with NPS fertilizer rates than unfertilized potato plants. Also, the biomass yield was increased as the rates of NPS fertilizer increases. Biomass yield increment in response to N, P and S fertilization indicates that all nutrients could exert a significant influence on biomass production and partitioning to the different parts of potato plant.

The increment of dry matter yield per plant was also more apparent in plants from the applied fertilizer which is probably due to less competition among the plants for nutrients. The findings of Millard and Marshall (1986) who reported a significant increment in canopy dry matter yield of potato as N application increased supports the results obtained in this study. The results of the present study clearly indicated that the application of NPS fertilizer increased biomass of potato varieties which are in line with the findings of various researchers (Sharma & Arora, 1987; Yohannes, 1994).

##### Average tuber number per hill

The Belete variety showed significantly higher tuber number per hill than local variety. Similarly, varietal

difference had significant influence on number of tuber per potato plant (Sharma *et al.*, 2015). The average tuber numbers per hill recorded from potato applied with NPS fertilizer rates were higher than unfertilized potato. Increasing stem density over a wide range either by planting larger seed tubers or more seed tubers for most varieties resulted in increased number of tubers per unit area (Allen, 1972; Gray and Hughes, 1978). Contradicting results have also been reported by different investigators regarding the effect of mineral nutrition on the number of tubers set per plant. As reported, the application of N, P and S significantly increased the number of tubers set per unit area (Lynch and Rowberry, 1997; Sommerfeldt and Knustan, 1965; Hanley *et al.*, 1965, Sharma *et al.*, 2015, Sharma and Arora, 1987; White and Sanderson, 1983) which correlate with the finding of this study.

#### **Average tuber weight per hill**

Average tuber weight per hill has been reported to be the third most important yield component of potato after stem and tuber number contributing to the total tuber yield (Lynch and Tai, 1989; De La Morena *et al.*, 1994). In agreement with the result of the present study, Sharma *et al.*, 2015, Berga *et al.* (1994) and Bereke (1994) reported that there were significant differences between varieties for average tuber weight of potato. Saluzzo *et al.* (1999) suggested that variety with higher average tuber weight in addition to its late maturity might also be more efficient in dry matter partitioning to tubers than variety with lower average tuber weight. In this study, the higher average tuber weight per hill was recorded in almost all NPS fertilizer supplied potato than unfertilized potato. The increased average weight of tubers with the supply of nitrogen fertilizer could be due to luxuriant growth, more foliage and leaf area and higher supply of photosynthate which helped in producing bigger tubers resulting in higher yield (Sharma and Arora, 1987). Also, this positive effect of N on tuber weight increase could be attributed to more interception of photosynthetically active radiation, more dry matter accumulation and partitioning to tubers (Saluzzo *et al.*, 1999). It also, influenced by P fertilizers through its effect on the number and size of tubers produced and the time at which maximum yield is obtained (Sommerfeldt and Knutson, 1965; Sharma and Arora, 1987). Also, Sulfur levels showed significant influence on average tuber weight per potato plant (Sharma *et al.*, 2011 and Sharma *et al.*, 2015).

#### **Tuber yield**

The marketable, unmarketable and total tuber yield from Belete variety was higher than Local variety. This could be the variation in genetical characteristics. Similarly, Alemayehu and Jemberie, (2018), Sharma *et al.*, (2015) and Sharma *et al.*, (2011) also reported significant variation in tuber yield of different potato varieties. On the other hand, the marketable, unmarketable and total tuber yields were obtained from potato which was supplied with NPS fertilizer rates. The lowest marketable, unmarketable and total tuber yield was obtained from potato which was not supplied with NPS fertilizer. In line with this finding, increasing NPS application rates in generally increased marketable, unmarketable and total tuber yields of the tested potato varieties (Alemayehu and Jemberie, 2018). The yield increment in marketable tuber yield due to increased phosphorus application in the presence of recommended nitrogen and sulfur implying that those mineral nutrient can contribute to produce more and healthy marketable size tubers due to their combination effect in delaying tuber growth associated with greater partitioning of dry matter to the above ground portion that ultimately contributed to the increased marketable and total tuber yield. Although P had shown a positive effect on tuber yield, the percentage of yield increment due to P was smaller than the yield increment due to N. This could probably be explained, at least in part, by a smaller increase in leaf area index due to P compared with the response to N. Moreover, P was reported to lead to earlier closure of canopy and shorten the growing period (Sommerfeldt and Knutson, 1965). Similarly, Sulphur levels showed significant influence on grade wise tuber yield (Sharma *et al.*, 2011 and Sharma *et al.*, 2015) This might be the increase in tuber yield with increasing sulphur levels may be due to its role in better partitioning of the photosynthates in the shoot and tubers (Sud and Sharma, 2002). Generally, the present study results revealed that application of NPS fertilizer increased tuber yields of potato varieties which agrees with the reports of Alemayehu and Jemberie, (2018), Yayah *et al.*, (2017), Boke, (2014) and Ayichew *et al.*, (2009).

### **5. Conclusion**

In the present study, most growth and yield components of potato varieties were increased with increased application rates of NPS fertilizer and their responses were different. Accordingly, the highest plant height of potato (87.60cm) was recorded on fertilizer rate of 111: 89.7:16.52kg ha<sup>-1</sup> of NPS fertilizer. The maximum days (124.3) to maturity of potato was recorded on Belete variety supplied with 111:89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer while the shortest days (111) was recorded on Belete variety in the nil fertilizer application. The higher aboveground biomass (91.8 g hill<sup>-1</sup>), underground biomass (261.2 g hill<sup>-1</sup>) and total biomass (352.9g hill<sup>-1</sup>) were recorded on Belete variety. In the case of fertilizer rates, while the highest underground biomass (290.9 g hill<sup>-1</sup>) and total biomass (378.8 g hill<sup>-1</sup>) of potato was recorded on potato fertilized with 55.5:89.7:16.52 kg ha<sup>-1</sup> NPS fertilizer treatment. The highest average tuber number per hill (15.67), tuber weight (1.82 kg hill<sup>-1</sup>), marketable (53.61 t ha<sup>-1</sup>), unmarketable (0.542 t ha<sup>-1</sup>) and total (54.15t ha<sup>-1</sup>) tuber yield was recorded on potato which was applied with 55.5: 89.7:16.52 kg ha<sup>-1</sup> of NPS fertilizer rate. Also, all the higher marketable (48.11 t ha<sup>-1</sup>), unmarketable (0.501t ha<sup>-1</sup>) and total (48.6t ha<sup>-1</sup>) tuber yield of potato were obtained from Belete variety compared

to the local variety. Therefore, producing potato with different NPS fertilizer rates in different potato variety had influence on yield and yield components of potato and applying of 55.5:89.7:16.52 kg ha<sup>-1</sup> rate of NPS fertilizer increased almost all yield and yield components of potato varieties.

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Table 1: Soil physical and chemical properties of the experimental site before planting

Soil texture	Content	Rating
Sand (%)	72	
Silt (%)	16	
Clay (%)	12	
Textural Class	Sandy loam	Sandy loam
Chemical properties		
pH	6.8	Slightly acidic
Electrical Conductivity (ds/m)	4.45	Slightly saline
Organic Sulfur (%)	0.0114	Very Low
Organic carbon (%)	1.326	High
Organic Matter (%)	2.286	Very High
Total Nitrogen (%)	0.1143	Low
Available Phosphorus (ppm)	11.18	Extremely low
Exchangeable Cations	Na <sup>+</sup> 0.391	
(meq/100g)	K <sup>+</sup> 1.242	High

Table 2:-The effect of variety and NPS fertilizer rates on plant height, stem number per hill and flowering days of potato at Abaso Kotu, Dessie Zuria district, Northeast Ethiopia.

Variety	Plant height (cm)	Number of stem hill <sup>-1</sup>	Days to flowering
Local	71.47	6.78	55.17 <sup>b</sup>
Belete	75.52	6.22	59.17 <sup>a</sup>
LSD	Ns	Ns	1.741
NPS fertilizer rate (N:P <sub>2</sub> O <sub>5</sub> :S)			
0:0:0	62.27 <sup>c</sup>	5.17	56.50
111: 89.7 : 0	69.40 <sup>bc</sup>	5.67	58.33
111: 89.7:16.52	87.60 <sup>a</sup>	7.17	55.17
55.5: 89.7:16.52	76.73 <sup>b</sup>	7.17	56.17
111: 44.85:8.26	70.10 <sup>bc</sup>	7.00	58.83
55.5 : 44.85:8.26	74.87 <sup>b</sup>	6.83	58.00
LSD	12.78	Ns	ns
CV	10.27	23.92	4.4

Means in columns with the same letter are not significantly different from each other at  $P \leq 0.05$ .



Table 3: Interaction effect of variety and NPS fertilizer rates on days to maturity of potato at Abaso Kotu, Dessie Zuria district, Northeast Ethiopia.

Fertilizer Rate (N:P <sub>2</sub> O <sub>5</sub> :S)	Variety	
	Local	Belete
	Days to Maturity	
0:0:0	113.33 <sup>de</sup>	111.00 <sup>c</sup>
111: 89.7: 0	114.67 <sup>d</sup>	114.00 <sup>de</sup>
111: 89.7:16.52	119.33 <sup>bc</sup>	124.33 <sup>a</sup>
55.5: 89.7:16.52	116.33 <sup>cd</sup>	120.00 <sup>b</sup>
111: 44.85:8.26	114.00 <sup>de</sup>	120.00 <sup>b</sup>
55.5 : 44.85:8.26	114.33 <sup>de</sup>	118.67 <sup>bc</sup>
LSD	3.428	
CV%	1.74	

Means with the same letter are not significantly different from each other at P ≤ 0.05.

Table 4. The effect of variety and NPS fertilizer rates on above ground biomass, below ground biomass, total biomass and tuber number of potato plant at Abaso Kotu, Dessie Zuria district, Northeast Ethiopia.

Variety	Above ground biomass (g hill <sup>-1</sup> )	Below ground biomass (g hill <sup>-1</sup> )	Total biomass (g hill <sup>-1</sup> )	Tuber number hill <sup>-1</sup>
Local	59.6 <sup>b</sup>	224.9 <sup>b</sup>	284.5 <sup>b</sup>	14.11
Belete	91.8 <sup>a</sup>	261.2 <sup>a</sup>	352.9 <sup>a</sup>	14.11
LSD	8.71	27.16	31.69	Ns
NPS fertilizer rate (N:P <sub>2</sub> O <sub>5</sub> :S)				
0:0:0	45.60 <sup>d</sup>	171.1 <sup>c</sup>	216.7 <sup>d</sup>	10.00 <sup>b</sup>
111: 89.7 : 0	73.47 <sup>bc</sup>	244.7 <sup>ab</sup>	318.1 <sup>bc</sup>	13.67 <sup>a</sup>
111: 89.7:16.52	103.24 <sup>a</sup>	264.9 <sup>ab</sup>	368.1 <sup>ab</sup>	15.00 <sup>a</sup>
55.5: 89.7:16.52	87.83 <sup>b</sup>	290.9 <sup>a</sup>	378.8 <sup>a</sup>	15.67 <sup>a</sup>
111: 44.85:8.26	73.2 <sup>bc</sup>	235.3 <sup>b</sup>	308.5 <sup>c</sup>	15.17 <sup>a</sup>
55.5 : 44.85:8.26	70.75 <sup>c</sup>	251.2 <sup>ab</sup>	322.0 <sup>bc</sup>	15.17 <sup>a</sup>
LSD	15.08	47.05	54.88	3.140
CV	16.6	16.2	14.4	18.6

Means in columns with the same letter are not significantly different from each other at P ≤ 0.05.

Table 5: The effect of variety and NPS fertilizer rates on average tuber weight, marketable yield, unmarketable yield and total tuber yield of potato at Abaso Kotu, Dessie Zuria district, Northeast Ethiopia.

Variety	Average tuber weight (kg hill <sup>-1</sup> )	Marketable yield (t ha <sup>-1</sup> )	Unmarketable yield (t ha <sup>-1</sup> )	Total Tuber (t ha <sup>-1</sup> )
Local	1.399 <sup>b</sup>	41.46 <sup>b</sup>	0.419 <sup>b</sup>	41.9 <sup>b</sup>
Belete	1.606 <sup>a</sup>	48.11 <sup>a</sup>	0.501 <sup>a</sup>	48.6 <sup>a</sup>
LSD	0.163	5.02	0.052	5.07
NPS fertilizer rate (N:P <sub>2</sub> O <sub>5</sub> :S)				
0:0:0	1.123 <sup>d</sup>	31.50 <sup>c</sup>	0.358 <sup>c</sup>	31.85 <sup>c</sup>
111: 89.7 : 0	1.330 <sup>cd</sup>	45.19 <sup>ab</sup>	0.455 <sup>ab</sup>	45.65 <sup>ab</sup>
111: 89.7:16.52	1.460 <sup>bc</sup>	48.78 <sup>ab</sup>	0.491 <sup>ab</sup>	49.27 <sup>ab</sup>
55.5: 89.7:16.52	1.817 <sup>a</sup>	53.61 <sup>a</sup>	0.542 <sup>a</sup>	54.15 <sup>a</sup>
111: 44.85:8.26	1.573 <sup>abc</sup>	43.36 <sup>b</sup>	0.44b <sup>c</sup>	43.80 <sup>b</sup>
55.5 : 44.85:8.26	1.710 <sup>ab</sup>	46.26 <sup>ab</sup>	0.475 <sup>ab</sup>	46.73 <sup>ab</sup>
LSD	0.283	8.69	0.090	8.78
CV	15.7	16.2	16.4	16.2

Means in columns with the same letter are not significantly different from each other at P ≤ 0.05.