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# Effect of Integrated NP and Vermicompost Fertilizer Rate on Yield and Yield Components of Potato (*Solanum tuberosum L.*) in Western Ethiopia

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**Abstract:** There are several factors that affect or hinder the productivity of potato in Ethiopia. From those factors soil fertility is the especial one. To overcome these problems, farmers were applying both organic and inorganic fertilizer to increase their production. Still there is scant of information to apply vermicompost combined with inorganic fertilizer for the production of crops. To solve the problem field experiment was conducted during the 2020/21 cropping season to assess the effect of integrated Vermicompost and NP fertilizers rate on yield and yield components of potato in Western Ethiopia. The experiment was laid out in randomized complete block design (RCBD) with three replications in factorial arrangement. The experiment comprising three levels of vermicompost 0, 5,7.5 t ha$^{-1}$ and five levels of NP fertilizers 0, 25%, 50%, 75%, 100% of blanket recommended rates of NP (110 kg N ha$^{-1}$ and 90 kg $P_2O_5$ ha$^{-1}$) of blanket recommended rates of NP (N, 110 kgha$^{-1}$ and $P_2O_5$, 90 kg ha$^{-1}$). The results indicated that highest marketable tuber number per hill, total tuber per hill and large sized tuber were significantly ($P>0.05$) affected by the main effect of 7.5 t ha $^{-1}$ vermicompost. Whereas, the highest marketable tuber number per hill, total tuber number per hill and large sized tubers were significantly ($P>0.05$) affected by the main effect of 100% NP fertilizers. More over the interaction effect of Vermicompost and NP fertilizers were significant ($P<0.05$) on 50% flowering, days to maturity, plant height, marketable tuber and total tuber yield. The results of this study conclude that, integrated use of organic and in organic fertilizer were the most use full application for the cultivation of potato.

**Keywords:** Vermicompost, Mineral Fertilizer, Marketable Yield

## 1. Introduction

Potato (*Solanum tuberosum* L.) belongs to the family *Solanaceae,* and accommodated in series *Tuberosa* [1]. Potato is the most important crop and ranked fourth in cultivation followed by wheat, maize and rice respectively [2]. It has a major role especially for food and to income generate for employers such as processors, producers and marketers [3]. In addition to food security potato provides important nutrients such as carbohydrates, minerals and vitamins. It has balanced protein and calories; due to this reason it considered as good weaning food [4].

Ethiopia has endowed with altitude, temperature, rainfall, soil type which is very suitable for potato production [5, 6]. Recently potato produced in wide range throughout the year using irrigation and rain fed patterns and it considered as “hunger breaking crop” because it can be grown and harvest when other crops doesn’t mature and harvest [7]. According to another scholar reported, Potato has short growth period and produced twice year$^{-1}$ thus, Belg (short rainy season - February to May) and Meher (long rainy season- from June to October) in Ethiopia. [8]

Production of potato in Ethiopia in 2015/16 cropping season was covered 296,577.59 hectares and harvested 3,657,638.26 tons [9]. The most potato producing counties are Netherlands, Germany, Egypt and Burundi which produced 40, 28, 17.4 and 11t ha$^{-1}$ respectively [10]. Ethiopia produces very low amount when compare to the others, which produced in average 16.4 t ha$^{-1}$. Other scholars reported that, in Ethiopia production of potato crop on research field 40 t ha$^{-1}$ as well as on farmers' fields 20 t ha$^{-1}$ average yield was harvested [11].

In Ethiopia optimum amount of fertilizer doesn't apply for crops especially for potato production because of different factors. Application of nitrogen and phosphorus 30.6 kg N ha$^{-1}$ and 76.5 kg $P_2O_5$ ha$^{-1}$ respectively and a little amount of organic fertilizer was used as estimated by [12]. Integrated application of fertilizer is very essential to enhance soil fertility that is providing optimum amount of nutrients to influence the yield of potato [13]. Application of organic or inorganic fertilizer alone is not enough for crop production and productivity, because it lacks essential nutrients which is used to complete plant life cycle [14]. According to the report, there are a lot of constraints that affect the productivity of potato such as poor soil fertility, high yielding varieties, and post-harvest losses due to poor handling and storage facilities [12, 15]. The purpose of the study was to assessing the effect of integrated Vermicompost and NP fertilizers rate on yield and yield components of potato.

# 2. Materials and Methods

### 2.1. Description of the Study Area

The experiment was conducted at farmer training center of Ejere district western Shoa of Oromia regional state on the way to Ambo, which is the western shoa zone during 2020/2021 cropping season. Ejere Agricultural office is located between 10°15'60" and 14° 98'48" N latitude and 41° 99'60" and 40° 17' 60'' E longitude. The elevation of study area was 1392-3350 meter above sea level with gentle slope (Ejere district agricultural office, 2010) and it has three agro-climatic zones namely Dega, Woynadega and Kola. The Annual rainfall was between1001-1680mm and the mean annual maximum and minimum temperature were 31 to 16°C, respectively. Soil type of the study area was 29% sandy, 37% clay and 43% silt.

### 2.2. Experimental Design and Treatments

The experimental design was laid out in Randomized Complete Block design (RCBD) with three replications. The treatments was consisting five levels of combined NP fertilizer 0, 25% (42 N kg /ha and 34 $P_2O_5$ kg/ha), 50% (83 N kg /ha and 68 $P_2O_5$ kg/ha), 75% (123 N/ha and 101.25 $P_2O_5$ kg/ha), and 100 % (165 N kg/ha and 135 $P_2O_5$ kg/ha) and three levels of VC (0, 5 and 7.5 ton/hectare) for jallene potato variety. The plot area was 3 x 4 m (12 m$^2$) with five rows of potato planted at spacing of 75 cm between rows and 30 cm between plants.

### 2.3. Data Collection

#### 2.3.1. Phonological Parameters

*Days to 50% flowering:* Flowering days was recorded from the beginning of planting day to when 50% of potato plants produce flowers.

*Days to 90% physiological maturity:* Maturity days were recorded from planting day to 90% of potato leaves was changed to yellow color.

#### 2.3.2. Growth Parameters

*Average stem number per hill:* Average steam number at 50% flowering stage was recorded as the average potato stems that grow and stand independently above the ground after counted from five hills per plot.

*Plant height (cm):* Measured the height of the plant, from the base to the apex at 90% physiological maturity stage by taking five main stem samples from each plot.

#### 2.3.3. Yield Component Parameters

*Total tuber numbers/hill:* Adding all marketable and unmarketable tubers, it constituted different size and growth appearance that were produced by the plants.

*Marketable tuber number/hill:* Count all tubers at weight of 25g which were free from diseases, insect attacks and deformed from each plot and it divided to the perspective number of plants harvested.

*Unmarketable tuber number /hill:* Count diseased, insect attacked, deformed tubers which were weight less than 25 g.

*Tuber size distribution in weight:* Collect tubers from five randomly selected plants in each plot and categorized a tuber its weight was 25-38g were small, 39-75g were medium, and >75 g were large respectively then converted to percentages. [3]

*Marketable tubers yield (t ha$^{-1}$):* Weight of marketable tubers: free from diseases, insect pests and greater than or equal to 25g weight [3] was recorded. These were taken from the net yield at harvest time and converted to t ha $^{-1}$

*Unmarketable tubers yield (t ha$^{-1}$):* Tubers yield was recorded; which were diseased, insect attacked, deformed and weight less than 25 g.

*Total tubers yield (t ha$^{-1}$):* Sum of all marketable and unmarketable tuber yields from net plot was recorded at harvested time and it was converted in to t ha $^{-1}$

### 2.4. Data Analysis

The measured parameters were subjected to Analysis of variance (ANOVA) according to the General Liner Model (GLM) of Gene Stat 15$^{th}$ Edition to see or cheek either the treatments and their interactions were statistically significant or not. Analysis of variance was conducted Using statistical software of Statistical Analysis System (SAS) package version of 9.0 [16]. Whenever the effects of the treatments were found to be significant, mean were compered using the least significant difference (LSD) test at the 0.05 probability level of significance [17].

# 3. Result and Discussion

Soil sample and laboratory analysis indicated that the soil textures of the experimental site were clay loam and soil acidity was medium. According to the report, Organic matter content of the soil was rated under low (Table 1) [18].

***Table 1.*** *Physicochemical Properties of the Experimental Site before planting potato.*

| | Percent (%) | Properties |
|---|---|---|
| Physical properties of soil | | |
| Sand | 29 | |
| Silt | 43 | |
| Clay | 37 | |
| Chemical properties of soil | | |
| Soil Acidity | 4.9 | Medium in acidic |
| Organic carbon | 1.62 | Medium |
| Total nitrogen | 0.153 | Medium |
| Available Phosphorus | 5.6 | Low |
| CEC | 25.13 | Medium |
| Organic matter | 3.0 | Low |

As indicated below on table 2, the chemical properties of vermcompost fertilizer before planting were alkalis in soil acidity (7.5), Total nitrogen (1.8), Available Phosphorus (0.92), Exchangeable potassium (2.7), Organic matter (5.81).

***Table 2.*** *Results of laboratory analysis of vermicompost (VC) used for the experiment.*

| Vermicompost parameters | Values % |
|---|---|
| Acidity | 7.5 |
| Total nitrogen | 1.8 |
| Available Phosphorus | 0.92 |
| Exchangeable potassium | 2.7 |
| Organic matter | 5.81 |

### *3.1. Phonological and Growth Parameters of Potato*

#### *3.1.1. Days to 50% Flowering*

Analysis of variance showed that days to 50% flowering of potato were significantly ($P < 0.05$) influenced due to interaction effect of NP fertilizers and Vermicompost. Below data showed that when increased rate of vermicompost and NP fertilizer, number of 50% flowering days was reduced (Table 3). This finding was concise with another result reported that, application of 10 t $h^{-1}$ VC with 75% NP kg $ha^{-1}$ fertilization prolong duration of potato as compared to the treatment that have no fertilizer [19]. Application of Vermicompost with NP fertilizer alone was delayed flowering day when compared to the treatment that received 7.5 t $VCha^{-1}$ and 100% NP.

***Table 3.*** *Interaction effect of vermicompost with NP fertilizer rates at 50 % flowering days of potato.*

| Vc (t $ha^{-1}$) | NP rate (%) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| 0 | 65.67$^{h}$ | 61.33$^{cdefg}$ | 60.5$^{cdefg}$ | 55.07$^{a}$ | 59.08$^{bc}$ |
| 5.0 | 60.00$^{bcd}$ | 60.67$^{cde}$ | 61.5$^{cdef}$ | 60.02$^{cdef}$ | 61.09$^{defg}$ |
| 7.5 | 63.00$^{g}$ | 60.77$^{cde}$ | 59.00$^{def}$ | 58.07$^{b}$ | 61.02$^{cdef}$ |
| LSD *5%* =1.653; CV % =1.7 | | | | | |

LSD = Least significant difference at 5% level; CV %= coefficient of variation; Means in the table followed by the same letters are not significantly different at 5% level of significance

#### *3.1.2. Day to 90% Physiological Maturity*

Analysis of variance showed that days to 90% maturity of potato were significantly ($P < 0.05$) influenced due to interaction effect of NP fertilizers and Vermicompost. Table 4 indicated that when increased rate of vermicompost and NP fertilizer; number of 90% maturity days was reduced when compeer to the treatment that received 7.5 t $VCha^{-1}$ and 100% NP. This result was similar with the finding of Amir et al. [20] who reported that, the application of integrated vermicompost and mineral fertilizer were reduces days of potato maturity. Only application of vermicompost and NP fertilizer alone was delay days of maturity when compare to the integrated one. This may be due to lack of optimum essential nutrient that adequate for growth of crops.

***Table 4.*** *Interaction effect of vermicompost and NP fertilizer rates at 90 % maturity of potato.*

| Vc (t $ha^{-1}$) | NP rate (%) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| 0 | 107.00$^{h}$ | 102.70$^{efg}$ | 102.30$^{defg}$ | 101.70$^{bcdefg}$ | 100.70$^{abcde}$ |
| 5.0 | 102.30$^{defg}$ | 101.70$^{bcdefg}$ | 102.00$^{cdefg}$ | 101.00$^{cdfg}$ | 103.03$^{fg}$ |
| 7. 5 | 103.70$^{fg}$ | 101.90$^{abc}$ | 102.02$^{a}$ | 100.04$^{abc}$ | 101$^{abcde}$ |
| LSD 5% = 1.653; CV % = 1.7 | | | | | |

LSD = Least significant difference at 5% level; CV %= coefficient of variation; Means in the table followed by the same letters are not significantly different at 5% level of significance

#### *3.1.3. Plant Height*

Analysis of variance showed that plant height of potato were significantly ($P < 0.05$) influenced due to interaction effect of NP fertilizers and Vermicompost. The maximum plant height (83.66cm) was observed from the treatment that received 7.5 t VCha$^{-1}$ and 100% NP integrated fertilizer and the shortest (59.90cm) were observed from the control treatment (Table 5). This result indicated that when increase the application of combined vermicompost and NP fertilizer, the height of potato was increased. The increment in plant height was might be due to the optimum amount of nutrients that released and use for the vegetative growth of potato plant [21]. Similar finding was reported that, the longest stem height was recorded from cow dung in combination with chemical fertilizer [22].

***Table 5.*** *Interaction effect of vermicompost and NP fertilizer rates on plant height of potato.*

| Vc (t ha$^{-1}$) | NP rate (%) | | | | |
|---|---|---|---|---|---|
| | **0** | **25** | **50** | **75** | **100** |
| 0 | 59.90$^{h}$ | 67.95 $^{g}$ | 69.69 $^{g}$ | 79.95$^{bc}$ | 79.89$^{bc}$ |
| 5.0 | 74.42$^{ef}$ | 75.35 $^{def}$ | 76.02 $^{de}$ | 76.94 $^{de}$ | 77.92$^{cd}$ |
| 7.5 | 76.55 $^{de}$ | 76.55 $^{de}$ | 77.95$^{cd}$ | 81.99$^{ab}$ | 83.66 $^{a}$ |
| LSD 5% = 1.653; CV % =1.7 | | | | | |

LSD = Least significant difference at 5% level; CV %= coefficient of variation; Means in the table followed by the same letters are not significantly different at 5% level of significance

### *3.2. Yield Component Parameters*

#### *3.2.1. Total Tuber Numbers Per Hill*

Analysis of variance showed that total tuber numbers per hill of potato was significantly ($P < 0.05$) affected by null application of vermicompost and NP. This result indicated that when total tuber numbers per hill was increase as increasing null application of vermicompost rate as well as NP fertilizer. The highest increment of total tuber number per hill was harvested from the treatment that received the highest vermicompost with NP, and the lowest tuber number per hill was obtained from null vermicompost and NP (Table 6). This result might be due to positive response of N and P application, which is influence the rate of hormones as well as number of potato tubers set per hill, was increasing rate of phosphorus and nitrogen [23, 24].

#### *3.2.2. Marketable Tuber Number Per Hill*

Analysis of variance showed that marketable tuber number per hill of potato was significantly ($P < 0.05$) affected by null application of vermicompost and NP fertilizer. This result might be due to availability of essential nutrients released from vermicompost and NP fertilizer. The highest marketable tuber number per plant was recorded from the treatment that received the highest vermicompost and NP fertilizer, while the lowest was recorded from the control (Table 6). This result was in accordance with the study reported, application of 46 kg N ha$^{-1}$ and 5 t ha$^{-1}$ vermicompost was increase marketable root yield of sweet potato by 48.55% as compared to control [25].

***Table 6.*** *Main effect of vermicompost with NP fertilizer rate on marketable, unmarketable and total tuber number per hill of potato.*

| Vermicompost (t ha$^{-1}$) | MTN per hill | UNMTN per hill | TTN per/hill |
|---|---|---|---|
| 0 | 7.20$^{c}$ | 6.21 | 11.49$^{c}$ |
| 5.0 | 8.85$^{b}$ | 6.27 | 12.800$^{b}$ |
| 7.5 | 10.50$^{a}$ | 5.53 | 13.89 $^{a}$ |
| LSD (5%) | 0.74 | 0.98 | 2.09 |
| NP (%) | | | |
| 25 | 8.20$^{c}$ | 6.24 | 12.32$^{c}$ |
| 50 | 9.43$^{b}$ | 5.44 | 12.65$^{bc}$ |
| 75 | 9.48 $^{b}$ | 5.79 | 13.05 $^{b}$ |
| 100 | 10.64$^{a}$ | 5.25 | 13.67$^{a}$ |
| LSD (5%) | 3.24 | 2.44 | 2.62 |
| CV (%) | 10.92 | 23.04 | 12.32 |

MTN= marketable tuber number per hill; UNMTN =unmarketable tuber number per hill; TTN = total tuber numbers per hill, LSD (0.05) = Least significant difference at 5% level; CV = coefficient of variation; NS = non-significant. Means in the column followed by the same letter(s) are not significantly different at 5% level of significant.

#### *3.2.3. Tuber Size Distribution in Weight*

Analysis of variance showed that tuber size distribution in weight was significantly ($P < 0.05$) affected for large, medium and small size tubers in main effect of vermicompost and NP fertilizer application. The highest tuber size distribution was recorded from the treatment that received the highest 7.5 t VCha$^{-1}$ vermicompost and 100% NP fertilizers. The reason for this result was might be due to the adequate amount of nutrients from vermicompost that increases the availability of phosphorus and nitrogen which is easily usable by crop as well as by NP mineral fertilizer which used to increase the tuber size. Similar result was reported by the research [26] high tuber number was recorded from the treatment that received 20 t $ha^{-1}$ compost combined with 225 kg $ha^{-1}$ phosphorus. Large amount of small size tubers was recorded from the treatment that received the lowest amount of VC and NP fertilizer. While, low quantity of small size tubers was observed from the treatment that received high vermicompost and NP fertilizers (Table 7). This study was in agreement with the finding of Hossain et al. [27] who reported that, maximum amount of tuber size was recorded when use of integrated organic fertilizer with inorganic.

***Table 7.*** *Main effect of vermicompost and NP fertilizer rate on large, medium and small size of potato.*

| Vermicompost (t $ha^{-1}$) | Large size in percent (%) | Medium size in percent (%) | Small size in percent (%) |
|---|---|---|---|
| 0 | 59.10$^{c}$ | 29.50$^{a}$ | 13.18$^{a}$ |
| 5.0 | 61.48$^{bc}$ | 28.37$^{a}$ | 11.22$^{b}$ |
| 7.5 | 70.21$^{a}$ | 25.15$^{b}$ | 8.64$^{c}$ |
| LSD (5%) | 2.64 | 1.99 | 1.62 |
| NP (%) | | | |
| 0 | 60.06$^{c}$ | 32.28$^{a}$ | 13.67$^{a}$ |
| 25 | 62.18$^{c}$ | 32.27$^{a}$ | 11.55$^{a}$ |
| 50 | 64.63$^{b}$ | 25.51$^{b}$ | 9.86$^{ab}$ |
| 75 | 67.13$^{a}$ | 23.24$^{c}$ | 8.64$^{b}$ |
| 100 | 71.79$^{a}$ | 22.83$^{c}$ | 8.38$^{b}$ |
| LSD (5%) | 2.96 | 2.23 | 1.81 |
| CV (%) | 5.7 | 10.1 | 21.3 |

LSD (0.05) = Least significant difference at 5% level; CV= coefficient of variation; Means in the table followed by the same letters are not significantly different at 5% level of significant.

### *3.3. Tuber Yield Parameters of Potato*

#### *3.3.1. Marketable Tubers Yield (t $ha^{-1}$)*

Analysis of variance showed that marketable tuber yield of potato were significantly ($P < 0.05$) influenced due to interaction effect of NP fertilizers and Vermicompost. The highest marketable tuber yield (37.10 t $ha^{-1}$) was obtained from the treatment that received the highest integrated application of (100 kg $ha^{-1}$ NP with 7.5 t $ha^{-1}$) NP and vermicompost fertilizers, while the lowest yield (10.81 t $ha^{-1}$) was recorded from the control (Table 8). The possible reason for this increment of marketable tuber yield was might be due to increasing soil nutrient that is used for vegetative growth and enable crops to produce greater photo assimilate. According to the report, nitrogen fertilization has significant influence on marketable tuber yield of potato [28, 21]. Similarly, N and P fertilization has significant effect on productivity of marketable tuber yields of potato [29, 30].

***Table 8.*** *Interaction effect of vermicompost and NP fertilizer rates on marketable tubers yield (t $ha^{-1}$).*

| Vc (t $ha^{-1}$) | NP rate (%) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| 0 | 10.81$^{i}$ | 12.29$^{k}$ | 13.79$^{h}$ | 13.89$^{h}$ | 14.45$^{h}$ |
| 5.0 | 17.66$^{j}$ | 18.50$^{ij}$ | 21.73$^{gh}$ | 26.23$^{ef}$ | 29.07$^{cd}$ |
| 7.5 | 29.83$^{cd}$ | 31.82$^{bc}$ | 33.02$^{ab}$ | 35.04$^{ab}$ | 37.10a |
| LSD 5% = 1.653; CV % = 1.7 | | | | | |

LSD (0.05) = Least significant difference at 5% level; CV= coefficient of variation; Means in the table followed by the same letter(s) are not significantly different at 5% level of significance

#### *3.3.2. Total Tuber Yield (Tty)*

Analysis of variance showed that total tuber yield of potato were significantly ($P < 0.05$) influenced due to interaction effect of NP fertilizers and Vermicompost. The highest marketable tuber yield (40.10 t $ha^{-1}$) was obtained from the treatment that received the highest integrated application of (100 kg $ha^{-1}$ NP with 7.5 t $ha^{-1}$) NP and vermicompost fertilizers, while the lowest yield (12.01 t $ha^{-1}$) was recorded from the control (Table 9). This result might be due to the positive effect of both nitrogen and phosphorus on total tuber weight [30]. According to the report, increment of total tuber yield was from nitrogen and phosphorus which is used to the vegetative growth and translocations of photosynthetic matters into the storage parts [28]. This result was consistent with the result of another scholar reported that, application of nitrogen was increase total tuber yield [21].

***Table 9.*** *Interaction effect of Vermicompost and NP fertilizer rates on total tuber yield (TTY).*

| Vc (t $ha^{-1}$) | NP rate (%) | | | | |
|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 |
| 0 | 12.01$^{k}$ | 17.50$^{l}$ | 18.00$^{i}$ | 18.89$^{j}$ | 18.93$^{j}$ |
| 5.0 | 21.66$^{gh}$ | 22.50$^{gh}$ | 23.73$^{gh}$ | 26.23$^{hi}$ | 29.07$^{de}$ |
| 7.5 | 31.43$^{cd}$ | 34.82$^{bc}$ | 37.02$^{ab}$ | 38.04$^{ab}$ | 40.10a |
| LSD 5% = 1.653 | | | CV % = 1.7 | | |

LSD (0.05) = Least significant difference at 5% level; CV= coefficient of variation; Means in the table followed by the same letter(s) are not significantly different at 5% level of significance

## 4. Conclusion

Analysis of variance showed that, there were significantly ($P < 0.05$) influenced due to interaction effect of NP fertilizers and Vermicompost on days to 50% flowering, days to 90% maturity, plant height, marketable tuber yield and total number per hill. Thus, the highest marketable tuber yield and total tuber yield was obtained from the treatment that received the highest rate of integrated Vermicompost and NP fertilizers. This study was indicated that, potato yield has more increment when integrated vermicompost with NP fertilizers application used. Therefore, the result were concluded that, the maximum tuber yield of potato ware recorded from the interaction of 7.5 vermicompost t $ha^{-1}$ with 100 NP fertilizer rate in the study area. Further experiments have to be conducted to recommend integrated vermicompost with NP fertilizers for higher yield and soil fertility in the study area.

## Data Availability

All agronomic data was taken from the experiment and it incorporeally reported in the article.

## Conflicts of Interest

The authors declare that they have no competing interests.

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## References

[1] Van Den Berg, R. G. and M. M. J. Jacobs, 2007. Molecular Taxonomy. pp: 55-76. In: Vreugdenhil, D., Bradshaw, J., Gebhardt, C., Govers, F., MacKerron, D. K. L., M. A. Taylor, Ross, H. A. (eds.), Potato Biology and Biotechnology. Advances and Perspectives. Elsevier. BV.

[2] Douches, D. S., 2013. Breeding and genetics for the improvement of potato (*Solanum tuberosum L.*) for yield, quality and pest resistance. http://potatobg.css.msu.edu/program_overview.shtml

[3] Lung'aho, C., B. Lemaga, M. Nyongesa, P. Gildermacher, P. Kinyale, P. Demo and J. Kabira, 2007. Commercial seed potato production in eastern and central Africa. Kenya Agricultural Institute, pp: 140.

[4] Berga, M. V. D., M. Boosman, I. Cucco, L. Cuna, N. Jansson, P. Moustier, L. Prota, T. Purcell, D. Smith, and S. V. Wijk (1993). Making Value Chain Work Better for the Poor: A tool book for practitioners of value chain analysis.

[5] Cavatassi, R., L. Lipper, and U. Narloch. 2011. Modern variety adoption and risk management in drought prone areas: insights from the sorghum farmers of Eastern Ethiopia. *Agricultural Economics* 42: 279– 292.

[6] FAOSTAT. 2008. Country Profile on potato production and utilization: Ethiopia.

[7] Kolech S. A., Halseth D., De Jong W., Perry K., Wolfe D., Tiruneh F. M. and Schulz S., 2015. Potato Variety Diversity, Determinants and Implications for Potato Breeding Strategy in Ethiopia. American Journal of Potato Research 92 (5): 551-566.

[8] CSA (Central Statistical Agency). 2014. Agricultural sample survey re- port on area and production (Private peasant holdings in Meher season). Addis Ababa: Statistical Bulletin.

[9] CSA (Central statistical agency), 2016. Agricultural sample survey, report on area, production and farm management practice of belg season crops for private peasant holdings. Volume V, Statistical Bulletin 578. Addis Ababa, Ethiopia.

[10] FAOSTAT (Food and Agricultural Organization Statistic), 2012. Crop Production Data, Available online at http://faostat.fao.org.

[11] MoARD (Ministry of Agriculture and Rural Development), 2012. Crop variety registers issue no. 15, Addis Abeba. Ethiopia, pp: 36.

[12] Gildemacher, P., W. Kaguongo, O. Ortiz, A. Tesfaye, W. Gebremedhin, W. W. Wagoire, R. Kakuhenzire, P. Kinyae, M. Nyongesa, P. C. Struik and C. Leewis, 2009. Improving potato production in Kenya, Uganda and Ethiopia. Potato Research, 52: 173-205.

[13] Monirul, M. I., S. Akhter, N. M. Majid, M. S. Alam and F. Jannatul, 2013. Integrated nutrient management for potato (Solanum tuberosum L.) in grey terrace soil, Australia Journal of crop science 7 (9): 1235-1241. ISSN: 1835-2707.

[14] Zeleke, G., Agegnehu, G., Abera, D., & Rashid, S. (2010). Fertilizer and soil fertility potential in Ethiopia: Constraints and opportunities for enhancing the system. IFPRI working paper, Addis Ababa, Ethiopia. Retrieved from https://www.researchgate.net/publi cation/277813347

[15] Hirpa, A., M. P. M. Meuwissen, A. Tesfaye, W. J. M. Lommen, A. O. Lansink, A. Tsegaye, and P. C. Struick. 2010. Analysis of seed potato systems in Ethiopia. American Journal of Potato Research 87: 537–552.

[16] SAS Institute Inc. SAS/STATA Guide for personal computer version 9.2 SAS Institute. Inc. Carry, NC, USA. 2008.

[17] K. A. Gomez and A. A. Gomez, Statistical Procedures for Agricultural Research, John Wiley & Sons, New York, NY, USA, 2nd edition, 1984.

[18] Tekalign Tadese, 1991. Soil, plant, water, fertilizer, animal manure and compost analysis. Working Document No. 13. International Livestock Research Center for Africa, Addis Ababa.

[19] Daniel, M., L. M. Pant and Nigussie Dechassa, 2008. Effect of integrated nutrient management on yield of potato and soil nutrient status of Bako, West Shewa. Ethiopian Journal of Natural Resources, 10: 85-101.

[20] Amir, A., R. Mohammad, T. Mohammad and F. Feaza, 2014. Influence of nitrogen fertilizer and cattle manure on the vegetative growth and tuber production of potato. International Journal of Agriculture and Crop Sciences, 4: 232-242.

[21] Yourtchi, M. S., M. H. S. Hadi and M. T. Darzi, 2013. Effect of nitrogen fertilizer and vermicompost on vegetative growth, yield and NPK uptake by tuber of potato (Agria CV.). International Journal of Agriculture and Crop Sciences, 5 (18): 2033-2040.

[22] Abou-Hussein, S. D., T. El-Shorbagy, A. F. Abou- Hadid and U. El-Behairy, 2003. Effect ofcattle and chicken manure with or without mineral fertilizers on tuber quality and yieldof potato crops. ISHS Acta Horticulturea, 608: 95-100.

[23] Zelalem Aychew, Tekalign Tsegaw and Nigussie Dechassa, 2009. Response of potato (Solanum tuberosum L.) to different rates of nitrogen and phosphorus fertilization on vertisoils at Debre Berhan, in the central highlands of Ethiopia. African Journal of Plant Science, 3: 16-24.

[24] Israel Zewide, Ali Mohammed and Solomon Tulu, 2012. Effect of different rates of nitrogen and phosphorous on yield and yield components of potato (Solanum tuberosum L.) at Masha District, Southwestern Ethiopia. International Journal of Soil Science, 7 (4): 146-156.

[25] Gezahegn Garo, andergachew Gedebo and Kelsa Kena, 2014. Combined effects of inorganic (NP) and Vermicompost (VC) fertilizers on root yield and above ground biomass of sweet potato (Ipomoea batatas (L.) lam.) at Delbo watershed SHEKA zone, Southern Ethiopia. Journal of Scientific Research and Reviews, 3 (2): 028-033, March 2014.

[26] Taheri, N., H. H. Sharif-Abad, K. Yousefi and S. R. Mousavi, 2011. Effect of organic manure with phosphorus and zinc on yield of seed potato. Australian Journal of Basic and Applied Sciences, 5 (8): 775-780.

[27] Hossain, A. B. M. S., M. A. Hakim and J. M. Onguso, 2007. Effect of manure and fertilizers on the growth and yield of potato. Pakistan Journal of Biological Science, 6 (14): 1243-1246.

[28] Getie, A. T., N. Dechassa and T. Tana, 2015. Response of potato (*Solanum tuberosum L.*) yield and yield components to nitrogen fertilizer and planting density at Haramaya, Eastern Ethiopia. J. Plant Sci., 3: 320-328.

[29] Zelalem, A., T. Tekalign and D. Nigussie, 2009. Response of potato (*Solanum tuberosum L.*) to different rates of nitrogen and phosphorus fertilization on vertisols at Debre Berhan, in the central highlands of Ethiopia. Afr. J. Plant Sci., 3: 16-24.

[30] Zewide, I., A. Mohammed and S. Tulu, 2012. Effect of different rates of nitrogen and phosphorus on yield and yield components of potato (*Solanum tuberosum L.*) at Masha District, Southwestern Ethiopia. Int. J. Soil Sci., 7: 146-156.