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**Review Article**

# Review on Compost and Mineral NP-fertilizer Application Rate Effects on the Yield and Yield Components of Potato (*Solanum tuberosum* L.)

**Guta Eshetu Gemmechu**

Horticulture and Seed Spices Technology Generating Research Case Team, Sinana Agricultural Research Center, Oromia Agricultural Research Institute, Bale Robe, Ethiopia

**Email address:**
eshetuguta@gmail.com, shitayeguta@gmail.com

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**Abstract:** The origin of potato is thought to be Peru; some authors, however, believe that it was also native to parts of Mexico [7]. The evidence is that potato was cultivated and utilized by Chilean and Peruvian people before the arrival of Spaniards. There is little doubt that South America, in the neighborhood of Quito, is the place from which potato was first carried early in the sixteenth century into Spain where potato culture spread throughout Europe and later to North American Colonies [14], [15]. Potato (*Solanum tuberosum* L.) belongs to family *Solanaceae* and is one of the most important vegetable cum starch supplying crop having high production per unit area per unit time. Potato, an underground tuber occupies prime position among the cash crops in India. Potatoes are rich source of vitamins, especially 'C' and 'B' and also minerals. Tubers contain 70-80% water, 20.6% carbohydrate, 2.1% protein, 0.3% fat, 1.1% crude fibre and 0.9% ash. Among major food crops, potato produces the highest dry matter and edible protein per unit area and time. It can fulfill the requirement of food for human consumption to a greater extent [4].

**Keywords:** Potato, Compost, Mineral Nitrogen Fertilizer, Phosphorus Fertilizer

## 1. Introduction

Potato (*Solanum tuberosum* L.) is the fourth most important food crop in the world after rice, maize and wheat in terms of human consumption [17], [16]. The quantity produced yearly exceeds 300 million metric tons and more than a billion people worldwide consume potato which is rich in carbohydrates, protein, vitamins, dietary fibers, simple sugars and minerals [5], [9]. For instance In Cameroon potato production exceeds 160,000 tons from over 50,000 hectare [10]

India is the second largest producer of potato in the world after China, with cultivation in an area of about 2.02 million ha and production of 46 million metric tons. Potato is grown almost in all the states of India except Kerala. In Chhattisgarh, it is cultivated in an area of about 37,888 ha with a production of 550,000 metric tons. Due to its productivity and high returns potato cultivation increases every year in this state. In 2012, India produced 45 million tons of potatoes on a 1.9 million hectares area [9]. The Indo-Gangetic plains region contributes 90% of total potato production in India. In this Further, shallow root system of potatoes makes them more prone to nutrient losses than other field crops region; the potatoes are usually grown on light textured soils having low water holding capacity.

In order to achieve high yield, potato requires cool weather, reasonable amount of nitrogen (N), phosphorus (P) and potassium (K) in the soil. Therefore, Growers should ensure as to how much nitrogen (N), phosphorus (P), and potassium (K) will be available from the manure to the plant during critical periods of emergence, tuberization, tuber bulking, and maturation. In addition, nutrient release and accumulation rates are likely to differ greatly depending on the timing of application. Another concern is the potential for tuber quality losses related to various disorders and diseases. Finally, concerns persist in regards to the survival time of pathogens in the soil originating from raw manure. These issues may

prevent growers from considering dairy or livestock manure application, and thereby not taking advantage of a product which could potentially reduce input costs, improves soil quality, and increase tuber yields.

On the other hand, Late blight of potato caused by *Phytophthora infestan*s, the most important disease attacking potato plants is determined that it can be controlled by using Compost [2]. Many soil- borne pathogens can be reduced by application of composts made of different raw materials [23] Currently it is believed that a combination of antagonistic microorganisms with mature compost may be more efficient in inhibiting disease than using single antagonistic microbial strains or compost alone [3], [29]. Recently, one alternative approach has been reported to treat plants with non aerated compost teas (NCT), [26] or watery-fermented compost extracts. Production and use of NCT is typically done by mixing compost, water, and optional nutrient additives in an open container, leaving it undisturbed for a defined number of days, and then applying it to plants [25]. Application of NCT has been shown to be significantly suppress several foliar plant diseases [19]. Compost tea, applied as a foliar spray is also reported to suppress late blight of potato plants [26] He added that compost tea made from either horse manure or cow manure was sprayed on potato foliage as a control measure against late blight. These teas were used either alone or with additional microorganisms added to the mix. Results revealed that compost + microbes were equal to application of Ridomil MZ fungicide for reducing late blight disease. Therefore, it is proved to be effective in controlling late blight potato [26].

*Objective*

To review the effects of Compost and NP mineral fertilizer application rate on the yield and yield components of Potato (*Solanum tuberosum* L.)

# 2. Literature Review

### *2.1. Response of Potato to P-fertilizer Application Rate*

Phosphorus is an important component of all plant cells. Sufficient quantities of P will stimulate early root growth and increase water-use efficiency. A shortage of P may result in poor keeping quality of the tubers. Fertilization recommendations for phosphorus are based on soil analyses and target yield. The phosphorus content of soils can be determined ac- cording to various methods. P does not easily leach from the soil and all of it can therefore be applied once-off at or before planting. This fertilizer can be obtained from both Organic and In organic forms. The research conducted at Debre Birhan, in Central High lands of Ethiopia shows that the yield and yield components of Potato is affected by doses of Phosphorous fertilizer. Among the levels of Phosphorous fertilizers used for the experiment application of 60kg/ha significantly increased the days to flowering by two days, plant height by 10.5cm, above ground biomass by 32%, Underground biomass by 28%, marketable tuber yield by 60% and marketable tuber number by 43%. Other parameters such as days to physiological maturity, stem number, total tuber yield and number of unmarketable yield and total unmarketable yield, average tuber weight, specific gravity, dry matter content and Harvest Index were not significantly influenced by Phosphorous fertilization [28].

Additionally Girma Abera and his colleagues also conducted experiment to determine the effects of p- fertilizer rate on the yield and yield components of potato on Nitosols of Bako in Ethiopia. They determined as P-fertilizer application rate significantly influence plant height, main stem number, and above ground biomass of the crop. [13], [11]..

### *2.2. The Effects of Nitrogen on the Yield and Yield Components of Potato*

The growth, development and yield of potato are mainly governed by availability of major nutrients required for its cultivation. Nitrogen is one of the most important elements needed for growth and a shortage can result in yield losses. However, an excess of N can also be detrimental because it can result in excessive foliar growth at the expense of tuber growth. Excess nitrogen also adversely affects the keeping quality of tubers, lowers the specific gravity, and may result in the development of hollow heart disorder. It is the major limiting factor for potato crop which improves vegetative growth and invariably increases yield, tuber per plant, tuber size as well as tuber numbers. Over application of N is a serious problem leading to large nitrogen losses through leaching and enrichment of reactive N constituent in the atmosphere, soil and water with consequent damage to ecosystem. Moreover, excessive nitrogen leads to poor tuber quality and delayed crop maturity, whereas, nitrogen deficiency usually results in poor vegetative growth and low yield. The experiment done at Chhattisgarh plains shows that Nitrogen fertilizer application rate significantly affects the yield and yield components of potato. Among the six levels of Nitrogen fertilizer used for the experiment applying 375 kg/ha of Nitrogen fertilizer shows maximum value of plant height, number of leaves per plant, number of shoots per plant, fresh weight and dry weight of shoot per plant and other yield attributing parameters such as number of stolon, fresh and dry weight of tuber per plant. However, highest value for number of tuber per plant and tuber per plot as well as tuber yield per plot and per hectare were recorded at application of 225 kg/ha of Nitrogen fertilizer [5].

In similar way the experiment conducted at Debre Birhan, in central highland of Ethiopia also indicated as Nitrogen fertilizer application rate affects the yield and yield components of Potato. Among the three level of Nitrogen fertilizer used for this study application of 207 kg/ha of Nitrogen fertilizer delayed date to flowering and physiological maturity by four and nine days respectively compared to the control. Similarly, it increased plant height by 24cm, above ground biomass by 224.5%, underground biomass by 108%, marketable tuber yield by 175%, Total tuber yield by 119%, marketable tuber number by 95.6%, Total tuber number by 34% and average tuber weight by 82%. In contrast, the Nitrogen fertilizer application significantly reduced tuber specific gravity and dry matter content without

affecting stem number and harvest Index [28].

Similarly, Girma Abera and his colleagues also conducted experiment on Nitosols of Bako Area in Ethiopia to determine the influence of N-fertilizer application rate on the yield and yield components of Potato. They reported the obtained result as application rate of Nitrogen fertilizer have significant effects on plant height, main stem number, days to flowering, days to maturity, tuber number and average tuber weight. They also found that increasing the rate of N-fertilizer application rate from 0-69kg/ha increases the tuber yield by 40.12% and 61.18% for Tolcha and Menagsha potato varieties used for their trial respectively. They also reported as the N-fertilizer application rate beyond 69kg/ha have no significant effects on the tuber yield [13].

Nutrient supply plays a major role in growth and development of plants as well as yield because nitrogen is an essential constituent of protein and chlorophyll. Among fertilizers, nitrogen is second most important nutrient after potassium. Nitrogen is essential for maintaining higher haulm growth, increased bulking rate, quality of tuber and more dry matter production [22].

Zebarth and Rosen also reported as Nitrogen is one of most often limiting for potato growth; application of fertilizer N is production and, in general, N application increases the proportion of larger-sized tubers [27]. Proper N management influences almost all of the important properties related to tuber yield and quality [20] Nitrate fertilization determine yield increase and although have an influence on potato chemical composition and tuber quality. Too much available N can have negative effects on tuber yield and quality; excess N at or before tuberization can reduce yield and specific gravity [4], [11]

Many experiments have shown that total tuber yield and size of potato tubers increase with nitrogen and also reported that increasing nitrogen application raises tuber number, but that too much nitrogen has the opposite effect.

### *2.3. Response of Potato (Solunum tuberosum L.) to Compost Application Rate*

Compost is one of important organic fertilizer prepared from different waste materials. Since it is prepared from different plant materials and other decomposable material it contains all necessary nutrients. Therefore, application of compost is the same with applying balanced diet for the crops. However its nutrient contents are very low. On the other hand compost is important fertilizer by controlling Late blight of potato caused by *Phytophthora infestans*. Late blight caused by *Phytophthora infestans* is the most important disease attacking potato plants [2], [21]. Many soil-borne pathogens can be reduced by application of composts made from different raw materials [23], [9]. Currently it is believed that a combination of antagonistic microorganisms with mature compost may be more efficient in inhibiting disease than using single antagonistic microbial strains or compost alone [3], [29]. Recently, one alternative approach has been reported to treat plants with non aerated compost teas (NCT), [26] or watery-fermented compost extracts. Production and use of NCT is typically done by mixing compost, water, and optional nutrient additives in an open container, leaving it undisturbed for a defined number of days, and then applying it to plants [25]. Application of NCT has been shown to be significantly suppressing several foliar plant diseases [25], [19]. Compost tea, applied as a foliar spray is also reported to suppress late blight of potato plants [25]. This indicates that compost Application has significant effect on the yield and Yield components of Potato by controlling diseases [25]

Additionally compost application has significant effect on the yield and yield related parameters of potato by using as weed controlling agent. This is determined by research conducted by M. D. Kleinhenz and J. Cardina at Ohio State University, USA. Nutrient and weed management are leading production-related challenges in organic farming systems. Soil nutrient effects on crop and weed growth and genetic variation in crop nutrient efficiency and canopy variables suggest that variety selection and soil amendment may have key, interactive roles in organic systems. The experiment was conducted to determine the effects of compost application on the weed density, yield and quality of potato in 2000-2001 for two consecutive years. The obtained result reveled that compost application increased the yield of the crop and size of tubers by 13-14%. Total and cull yield and the percent by weight of the crop and Tuber size classes were unaffected by compost application. Weed densities and biomass were very low in both years, and were not influenced by compost treatments [18].

### *2.4. Response of Potato to Integrated Application Rate of Compost and Mineral NP-Fertilizer*

The integration effects of compost and NP- fertilizer trial had conducted at Angacha and Kokate in southern Ethiopia, during 2005 and 2006 growing season. The results obtained showed that compost increased tuber yield at both location but there is no significant variation among the treatment. Among the levels of NP-fertilizer used for the experiment highest yield 34ton/ha and 30.54ton/ha were obtained at Angacha and Kokate by application of 111kg/ha of Nitrogen fertilizer and 39kg/ha P-fertilizer without compost, showing yield advantage of 11.6ton/ha and 13.95ton/ha at both location respectively over control. This application rate is reported as more economical than others. It is also determined that application of 10ton/ha of Compost and 73.4kg/ha of N-fertilizer with 26kg/ha of P-fertilizer as gave yield advantage of 6ton/ha and 10.8ton/ha over control at Angacha and Kokate respectively. Consequently using either 111kg/ha of N-fertilizer with 39kg/ha of P-fertilizer or 10ton/ha of compost with 73.4kg/ha of N-fertilizer with 26kg/ha of P-fertilizer was recommended for local farmers depending on their interest and availability their resource for Compost preparation and purchasing of fertilizer [1].

Additionally, the effects of compost supplemented with NP-fertilizer on the yield and yield components of potato had conducted in West Gojjam, North western Ethiopia. The result of the experiment showed that Compost and NP-fertilizer application significantly increased total and marketable tuber yield. High total tuber yield (24.7ton/ha) and marketable tuber

yield (22.13ton/ha) was recorded at the interaction effects of 15ton/ha and 110/40kg/ha of NP-fertilizer. Increasing the rate of compost and NP-fertilizer significantly increased major yield components such as plant height, marketable tuber number and average tuber weight and significantly decreased days to flowering and maturity. However increasing the rate of compost and NP-fertilizer did not influence stem number and unmarketable tuber number [12]

# 3. Summary and Conclusion

Potato is thought to be originated from Peru. It belongs to the family *Solanaceae* family. Potato plant grown from adventitious roots at the base of each sprout and Later above the nodes of the underground parts of each stem. The type of potato root system varies from light to superficial to fibrous and deep. The yield and yield components of potato can be affected by environmental factors such as Temperature, solar radiation, Humidity and Edaphic factors. Additionally Biotic factors such as diseases and insect pests are the major factors affect the growth and developments of potato. Ideal soil for potato growing is deep, well drained and friable. Tuber quality and total yield can be affected by fertilization and application method. To increase the yield and yield components of Potato fertilizer should be applied appropriately. Potato plant has poorly developed root system and therefore, fertilizer is mainly applied in planting furrows at the time of planting. Phosphorous does not easily leach from the soil and all of it can be applied once-off at or before planting. Potato is reported as significantly affected by P-fertilizer application rate [28]. Compost is important Organic fertilizer used to control diseases such as Late blight potato Suppress weeds, Increase yield of potato. It was reported that application of compost with microbes was equal with application of Redomil MZ fungicides to control Late blight potato [25].

The Integrated effect of compost and NP- fertilizer is determined as significantly affect the yield and yield components of Potato [1]. Using compost for potato production is very important in conserving environment by reducing pollution due to chemical fertilizer and reducing cost of production. Therefore farmers have to use this simple technique of increasing yield with lower production cost.

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