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Review on the effects of nitrogen fertilizer rates on growth, yield components and yield of potato (*Solanum tuberosum* L.)

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Abstract
Potato is one of the most crucial food vegetation worldwide, and ranks 1/3 after rice and wheat in terms of human consumption. It is has been indicated, potato tubers are the subterranean swollen, starchy tubers of the potato plant and are of utmost popularity as staple food for thousands of tens of millions of humans in the world. Nitrogen performs critical function in all dwelling tissue of the plant. No different factors have such an effect on merchandising vigorous plant growth. Abundant of protein tends to increase the measurement of the leaves accordingly, to carry about an increase in carbohydrate synthesis. According to specific literature reviews the production of potato is constrained via specific factors, among these, insufficient application of nitrogen fertilizers is outstanding one. Hence farmers produce potato for meals crop rain fed conditions. However, there is no a complete suggestion for Nitrogen fertilizers. Hence, information is missing on the gold standard nitrogen fertilizer rates. Nitrogen fertilizer supply and rate notably interacted in all vegetative growth traits as expressed by using plant length, leaf number/plant, leaf area/plant, leaf chlorophyll content, and plant clean and dry weights. Nitrogen rate will increase the total tuber number, marketable whole number, complete tuber yield, marketable tuber yield and average tuber weight with growing nitrogen utility rate. The growing in quantity of marketable with increasing in application nitrogen is related with reduce in the range of small dimension tubers due to extend in the weight of character tubers.

Keywords: nitrogen fertilizer, marketable yield, potato, tuber weight

Introduction

Background and Justification

Potato (*Solanum tuberosum* L.) is a plant of the Solanaceae household and the world's most extensively grown tuber crop ranking fourth after rice, wheat and maize; and 40% of the world potatoes are grown in Europe, 35% in different developed countries and 25% in the rest of the world (Gul *et al*., 2011) [23]. It is concerned with from Western South America is the essential middle of the starting place and diversity of the potato crop and its wild relatives. Present-day landrace gene swimming pools take place from 45° south in Chile to 12° northern latitude in Colombia (Hawkes, 1990) [24].

According to (FAOSTAT, 2019) the world devoted 18.6 million ha (46 million acres) in 2018 for potato cultivation. The average world farm yield for potato used to be 17.4 tons per hectare, in 2010. Potato farms in the United States had been the most productive in 2010, with a nationwide common of 44.3 lots per hectare and United Kingdom has a shut second. In 2016, world manufacturing of potatoes was once 377 million tones, led via China with over 26% of the world total production. Other principal producers had been India, Russia, Ukraine and the United States. It remains an essential crop in Europe (especially northern and jap Europe), the place per capita production is nonetheless the best possible in the world, but the most fast extension over the previous few decades has befell in southern and eastern Asia (Steven, 2010).

Potato is one of the most necessary meals vegetation worldwide, and ranks 1/3 after rice and wheat in phrases of human consumption. It is has been indicated, potato tubers are the subterranean swollen, starchy tubers of the potato plant and are of utmost importance as staple meals for thousands of tens of millions of human beings in the world (John, 2017) [31].

Apart from utilization as food, potatoes can be used in ethanol production, yield pulp for paper industry and they may additionally supply uncooked material to the chemical industry (FAO, 2017) [16]. Potato is viewed as a high-potential food-security crop due to the fact of its ability to grant an excessive yield of tremendous product per unit enter with a shorter crop cycle (mostly < a hundred and twenty days) than main cereal plants like maize (Hirpa, 2010) [25].

According to (John, 2017) [31], record that at least six foremost potato roles can be assigned to the potato tuber: as a hunger-relieving crop; as food, either fresh, processed or as animal food; as a propagule, from which to produce the next crop; as a rated stock in enterprise for starch and alcohol; as an object of commerc.e; and as a aid of biodiversity. Potatoes are grown and eaten in more countries than any other crop; they are grown in all the continents besides Antarctica. The international economy; they are the fourth most vital crop in complete production and the fourth biggest contributor to human caloric consumption, after the three cereals, rice, wheat and maize. Different pupils located out that the most useful response to Nitrogen fertilizer application differs with the aid of cultivar and soil type.

Fertilizer application works satisfactory supplied that soil test has been accomplished (Shadrack and Nyawade, 2018) [42]. Newly launched potato cultivars require additional revision to improve great administration pointers for Nitrogen fertilization of potato and for optimization of tuber yield and quality. Nitrogen is the mineral nutrient most commonly poor in agricultural soils (Saeidi *et al*., 2009) [40].

Nitrogen is one of the principal plant vitamins had been great stage of grain and foliage production on verti soil depend on its enough supply. Although nitrogen necessities of crop met through addition of nitrogen fertilizer, it is an expensive enter and these mirror its low consumption in Ethiopia highlands (Murinen, 2007). According to one of a kind literature reports the manufacturing of potato is constrained by means of exclusive factors, among these, insufficient utility of nitrogen fertilizers, is outstanding one. Due this its production is low. Hence farmers produce potato for food crop rain fed conditions. However, there is no a whole recommendation for N fertilizers. Hence, records is missing on the superior nitrogen fertilizer rates (Bezabih and Mengistu, 2011).

Objective

To evaluation the impact of nitrogen fertilizer prices on growth, yield and yield aspects of potato.

Literature review

Origin and distribution of potato

Western South America is the major center of the origin and diversity of the potato crop and its wild relatives. Contemporary landrace gene pools happen from 45° south in Chile to 12° northern latitude in Colombia (Hawkes, 1990) [24]. The evolutionary origin of the cultivated potato has no longer yet been conclusively unraveled, and geneticists, archaic botanists, and taxonomists alike have explored special hypotheses for nearly 9 a long time (Spooner *et al*., 2014) [43].

According to (Van der Berg and Groendijk-Wilders, 2014), over 99% of European extant modern-day cultivars possess Chilean cytoplasm. Yet, the level of intraspecific diversity within the S. tuberosum Chilotanum team is modest compared with the Andigenum group. Its contemporary distribution vary is basically limited to the Chiloe Island of south-central Chile (Contreras and Castro, 2008; Manzur, 2012) [8]. Two hypotheses are many times put forth regarding the beginning of Chilotanum landraces (Spooner *et al*., 2012) [44]. The first suggests that they originated independently in southern Chile, perchance involving the putative wild ancestor Selenium maglia (Dillehay, 1997 and Ugent *et al*., 1987) [11] or hybrids of *Solanum tarijense* (*Solanum berthaultii*) (Hosaka, 2003 and Spooner *et al*., 2014) [27, 43].

Botanical description of potato

Potato has a rather shallow, fibrous root device with the majority of the roots in the surface 30 cm depth.

The root device develops hastily during early increase and achieves maximum improvement by means of mid-season. Thereafter, root length, density and root mass limit as the plant matures. Rooting depths of 1.2 m or more have been stated for potato under favorable soil stipulations (Birtukan Belachew, 2016) [5]. Potato can persist in the field through vegetative potential (as tubers) from one season to the subsequent (Anonymous, 2004) [3]. The crop is reasonably tolerant to forest, and is a C3 plant with a low mild saturation point. The potato has 5 wonderful increase stages: Sprout development, plant establishment or vegetative boom tuberizaiton (tuber formation), tuber bulking, and subsequently tuber maturation (Verhagen, 2008).

Potato has an indeterminate increase sample and produces a fibrous device of adventitious root system, which develops just above the nodes on underground portion the stem (Eremev *et al*., 2007). The potato tuber is an enlarged swollen underground stem with variable shapes and sizes. The swelling of the tuber is due to the translocation and storage of photosynthesis (carbohydrates), which retains its most with maturation of the aerial element of the plant. Hence, tuber boom and improvement of potato in general depends on the presence of ample foliage that produces the fundamental assimilates. Tuber are additionally used in industrial propagation for the reason that the seeds of potato are heterozygous and exceedingly variable via nature, seed purity can solely be maintained through vegetative propagation (Horton, 2006). Tubers are underground fleshy stems with eyes and they are suitable for ware (consumption), food processing, seed and animal rated. The development of a seed tuber starts offevolved with a dormant section (Struik, 2006) [25].

Potato production and productivity

The world committed 18.6 million ha (46 million acres) in 2010 for potato cultivation. The average world farm yield for potato was once 17.4 heaps per hectare, in 2010. Potato farms in the United States had been the most productive in 2010, with a nationwide average of 44.3 tons per hectare. United Kingdom used to be a shut second (FAOSTAT, 2019). In 2016, world production of potatoes used to be 377 million tones, led by means of China with over 26% of the world complete. Other most important producers were India, Russia, Ukraine and the United States. It remains an indispensable crop in Europe (especially northern and eastern Europe), the place per capita manufacturing is nonetheless the very best in the world, but the most rapid enlargement over the past few decades has took place in southern and japanese Asia (Steven, 2010).

The complete world potato manufacturing is estimated at 388, 191, 000 heaps in 2017 (FAOSTAT, 2019). The world potato sector is undergoing primary changes. Until the early 1990s, most potatoes have been grown and fed on in Europe, North America and international locations of the former Soviet Union. Since then, there has been a dramatic extend in potato production and demand in Asia, Africa and Latin America, where output rose from much less than 30 million lots in the

early 1960s to more than a hundred sixty five million lots in 2007.for the first time, the developing world's potato production handed that of the developed world (FAO, 2005). China is now the biggest potato producer, and almost a 0.33 of all potatoes are harvested in China and India (FAOSTA, 2019).

Potato is a perennial plant of the Solanaceae family and the world's most widely grown tuber crop ranking fourth after rice, wheat and maize; and 40% of the world potatoes are grown in Europe, 35% in other developed international locations and 25% in the rest of the world (Gul *et al*., 2011) [23].

Nitrogen available form and uptake

Nitrogen available structure Atmospheric N is the primary reservoir for N in the N cycle (air is 79% N2 gas). Although unavailable to most plants, giant quantities of N2 can be used through leguminous flora by using organic N fixation. In this biological process, nodule-forming Rhizobium microorganism inhabit the roots of leguminous vegetation and thru a symbiotic relationship convert atmospheric N2 to a form the plant can use. Any component of a legume crop that is left after harvest, which includes roots and nodules, can provide N to the soil gadget when the plant material is decomposed. Several non-symbiotic organisms exist that repair N, however N additions from these organisms are quite low. In addition, small amounts of N are introduced to soil from precipitation (Jensen and Thomas, 2010) [30].

Commercial N fertilizers are additionally derived from the atmospheric N pool and fundamental step is combining N2 with hydrogen (H2) to shape ammonia (NH3-). Anhydrous ammonia is then used as a starting point in the manufacture of other nitrogen fertilizers. Anhydrous ammonia or different N merchandise derived from NH3- can then complement different N sources for crop nutrition. Nitrogen can additionally come to be accessible for plant use from natural N sources. But first these natural sources ought to be transformed to inorganic forms earlier than they are available to plants. Soil organic depend is also a predominant source of N used with the aid of crops. Organic rely is composed specifically of as an alternative secure cloth known as humus that has amassed over a long period of time.

Easily decomposed portions of natural material disappear surprisingly quickly, leaving at the back of residues extra resistant to decay. Soils include about 2, 000 pounds N in organic types for each percent of organic matter (WSN, 2018) [47].

Uptake of nutrients through crop plant life in enough amount and percentage is very essential for producing higher yields. Similarly, distribution of absorbed or amassed vitamins in shoot and grain (higher N in grain) is associated with yield enchancment (Fageria and Baligar, 2005) [13]. Nutrient uptake in crop flowers is usually measured with the aid of tissue analysis. Nutrient distribution in grain compared to total uptake in the plant is recognized as nutrient harvest index. It needs to not be burdened with grain harvest index, which is the ratio of grain weight to grain plus straw weight (Fageria, 2009) [14].

Nitrogen uptake efficiency reflects the efficiency of the crop in acquiring N from the soil (Majid, *et al*., 2010) [35]. Nitrogen use efficiency (NUE) in crop plant life is defined in several approaches in the literature (Fageria and Baligar, 2005) [13].

In easy terms, affectivity is ratio of output (economic yield) to input (fertilizers) for a procedure or complicated machine (Fageria, 2009) [14]. Agronomic efficiency may be defined as the vitamins gathered in the above-ground section of the plant or the vitamins recovered within the whole soil-crop root gadget (Roberts, 2008).

Nutrient management in potato

Effective administration of nutrients is quintessential for potato production, as tuber yield and tuber best are immediately impacted via extent and timing of nutrient applications. According to (Love and Stark, 2004) [34] referred to that each and every potato variety well-known shows special traits and for this reason existing unique management challenges. These varietal differences can impact each and every component of production, from seed production to storage condition. A wide variety of elements that negatively affect affectivity can be mentioned. Split application of Nitrogen is vital in order to keep away from loses through leaching, volatilization, denitrification, utilization via weeds, erosion by means of running-off water and sedimentation (Shadrack, 2018) [42].

The different elements that can decrease the trouble of soil as well as nutrient loss, as mentioned by (Shadrack *et al*., 2016) [42].

Nitrogen management for the enchancment of N efficiency is a excessive priority in potato cropping systems; typically, N is the most limiting nutrient in crop production and is higher in attention than all different mineral nutrients in most flora (Hopkins *et al*., 2008) [26].

Nitrogen grant is managed in accordance to market lessons (table stock, French fries, and potato chips), which require distinctive exceptional parameters (Blumenthal *et al*. 2008) [6]. It is feasible to improve crop yields and consequently N use efficiency via adopting soil and crop management practices. These practices include the liming of acid soils; splendid source, rate, and timing of N application; supply of adequate soil moisture; crop rotation; conservation or minimum tillage; use of cowl plants and animal manures; use of N-efficient crop species or genotypes inside species; and control of diseases, insects, and weeds (Fageria, 2009) [14].

Noura *et al*., (2016) [38] reported that the approach of using controlled-release N fertilizers, such as polymer-coated urea (PCU), should limit N losses and enlarge N use efficiency (NUE) by means of matching the launch of N with potato N uptake. The organic nutrient management is primarily based on crop rotations, solid and liquid animal manures, inexperienced manures and compost (Finckh *et al*., 2006) [19].

Role of nitrogen on growth of potato plants

N is the motor of plant growth. It makes up 1-4% of dry remember of the plant. It is taken up from the soil in the form of nitrate (NO-3) or ammonium (NH + 4). In the plant, it combines with compounds produced by carbohydrate metabolism to shape amino acids and proteins. Being the fundamental constituent of proteins, it is worried in all the main methods of plant development and yield formation. A top supply of nitrogen for the plant is also important for the uptake of the other vitamins (Bell, 2016) [4].

There are many investigations with appreciate to the consequences of N fertilization on the productivity of unique crops. However, the scope of this review is focused on the results of N fertilizer on potato production. According to (Jatav *et al*., 2017) [29] application of N exerted massive have an impact on all the growth parameters that is displaying fantastic increment.

Similar report is bought via (Kołodziejczy, 2014) [33] each application of N doses prompted a marked increase in potato-plant productiveness as compared to a smaller dose.

Potato is excessive nutrient annoying crop. Therefore, a hundred and fifty kg ha-1DAP and 117 kg ha-1 urea must be utilized as

recommended with the aid of researchers and also established by CASCAPE project. The whole DAP must be applied all through planting time while, urea should be utilized three instances in which one third at the time of planting, the other one 0.33 at two weeks after emergence and the last one the third at the initiation of flowering. Fertilizer need to be positioned barely below the seed tubers to avoid contact between the seed fertilizer (Asresie *et al*., 2015) [1].

Effects of nitrogen fertilizer rate on growth performance of potato

N fertilizer source and price drastically interacted in all vegetative growth characteristics as expressed by plant length, leaf number/plant, leaf area/plant, leaf chlorophyll content, and plant sparkling and dry weights. Using NH4NO3 at a charge of 230 Kg/fed resulted in the easiest values in all studied vegetative parameters accompanied through CO (NH2)2 with the equal rate, whilst the lowest values of all stated parameters have been recorded by using the use of (NH4)2SO4 at a charge of one hundred thirty Kg/fed. The frequent style is that vegetative boom values elevated with increasing Nitrogen application rate (Abdella and Gamel, 2015).

Effect of nitrogen fertilizer on plant height of potato

According to Sanjana *et al*., (2014) the nitrogen fertilizer charge improved from zero to 138kg/ha-1 (0, 46, ninety two and 138) accelerated the plant height from 55.86 to 72.58 cm. So, the most plant top at 138 kg ha-1is located 72.58 cm and minimum plant peak at 0 (control) is located 55.86 cm expanded nitrogen fertilizer rate from manipulate (0) to 138kg ha-1 extended the plant height.

According to Firew *et al*., (2016) [20] who applied 4 costs of nitrogen (0, 56, 112 and 168 Kg N ha−1) and that plant top amplify with increasing of nitrogen stage up to 168 kg ha−1.The Maximum plant top used to be observed (88.67 cm). According to Alemayehu *et al*., (2015) [2] states that for the duration of the wet season of 2012 to a sure impact of nitrogen and plant density on yield and yield factors of potato that utility of 110 kg ha−1 increases the plant peak through 12 cm over the manage treatment.

Fayera, (2017) [18] said that the utility of nitrogen fertilizer has an impact on plant top additionally discovered that increasing the N-fertilizer application at a rate from 0 to a hundred and fifty kg ha−1 will increase by way of 38.58 cm over control treatment. Similarly, (Zelalem and Nigussie, 2009) [48] demonstrated that nitrogen at a rate of 207 kg ha−1 will increase plant height with the aid of 24 cm. This is due to the truth that extended awareness of nitrogen fertilizer can increases the nitrogen uptake. This increment has a positive effects on the chlorophyll concentration the photosynthetic rates the leaf expansion the complete quantity of go away and the dry matter accumulation.

Effect of nitrogen fertilizer on stem wide of potato

According to (Nizamudin et al., 2003, Hassanpanah et al., 2009 and Alam et al., 2007) the fundamental stem number per hill can growing utility of nitrogen from 0 to a hundred sixty five kg ha-1 accelerated primary stem variety per hill from 3.14 to 5.35cm.Increasing rate of nitrogen from 0 to one hundred sixty five kg ha-1 accelerated the fundamental stem wide variety through 54.26%. An expand in nitrogen level up to 110 kg N ha-1 delivered about an enlarge in stem range per hill. This would possibly be related to the fact that fundamental stem quantity is mainly based on the quantity of sprout per tuber have said that the lowest stem number of potato is got from unfertilized control.

According to Shakh *et al*., (2001) have also stated that extended in stem number with an make bigger in nitrogen application (180 kg N ha-1). Opposite to this, (Jamaati and Somarin *et al*., 2009) [40] mentioned that increasing nitrogen degree up to a hundred and ten kg N ha-1 extended the stem number; but further increases in nitrogen fertilizer degree did no longer affect it anymore and Stem number did no longer have significant version inside its increase duration due to the fact it is a personality which is more often than not based on tuber size.

Effects of nitrogen fertilizer rates on yield and yield components of potato

Shoot dry weight

Application of one hundred sixty five kg N ha-1 extended shoots dry weight from 52.75-72.25 by 19.5 g per hill. This accelerated in shoot dry weight is 37% as in contrast to manage treatment. This is due to the fact that, multiplied awareness of nitrogen fertilizer can extend the nitrogen uptake and this enlarge has superb impact on chlorophyll concentration, photosynthetic rate, leaf expansion, total wide variety of leaves and dry count accumulation.Consequently, nitrogen fertilizer performs an important function in canopy development particularly on the shoot dry be counted (Najm *et al*., 2010) [37].

Root dry weight

According to Isreal Zewide *et al*., (2012) the application charge of 165kg N ha-1 the highest root dry weight was found (11.56 g hill-1) as in contrast to the control remedy (0), whilst the lowest root dry weight was once determined (8.90 g hill-1). This may be due to the effect of nitrogen that encouraged the increase and development of roots.

According to Fayera, (2017) [18] stated that increasing rate of nitrogen amplify average tuber weight plant−1, marketable tuber weight, unmarketable tuber weight, whole tuber yield plot−1, yield, tuber number plant−1 and small tuber size.

Nitrogen charge increases the total tuber number, marketable total number, total tuber yield, marketable tuber yield and average tuber weight with growing nitrogen up to 165 kg ha−1 (Alemayehu *et al*, .2015) [2]. Similarly the nitrogen utility at rate of a hundred and ten kg ha−1 and 165 kg ha−1 gave the highest marketable complete yield. However; that amplify price of nitrogen utility decreases the tuber yield of potato (Desalegn *et al*., 2016) [9].

Total tuber number increasing the utility of nitrogen from zero to 165kg ha-1 increased whole tuber quantity per hill from 9.77 to 12.19 this can be attributed to extended vegetative growth of potato plant (Mahmoudabad *et al*., 2010).

According to Debasis *et al*., (2018) [10] marketable tuber wide variety extended with multiplied rate of nitrogen fertilizer. Hence, increasing price of nitrogen application from 0-165kg N ha-1 improved marketable tuber range from 5.68-8.88/hill without affecting the unmarketable tuber number. The increasing in wide variety of marketable with growing in application nitrogen is related with decrease in the range of small dimension tubers due to make bigger in the weight of character tubers. Total tuber yield increasing the application rates of nitrogen growing the whole tuber yield from 23.75 to 38 t ha-1.while, the absolute best yield is obtained at one hundred sixty five kg N ha-1 but the lowest yield is bought at zero nitrogen application. Increased the application quotes of nitrogen from 0 to one hundred sixty five kg N ha-1 expanded complete tuber yield by using 60.33%, Average tuber weight the

easiest common weight of tubers (70.23 g) at a hundred sixty five kg N ha-1 and the lowest average weight of tuber (54. 47 g) at bought at zero application. Increased application charge of nitrogen from 0-165 kg N ha-1 increased common tuber weight via 22.43% as in contrast to the control.

Summary and Conclusion

Potato is one of the most essential food vegetation worldwide, and ranks 0.33 after rice and wheat in phrases of human consumption. It is has been indicated, potato tubers are the subterranean swollen, starchy tubers of the potato plant and are of utmost importance as staple food for hundreds of millions of people in the world.

Nitrogen plays indispensable function in all living tissue of the plant. No different factors have such an effect on merchandising lively plant growth. Abundant of protein tends to increase the measurement of the leaves accordingly, to convey about an enlarge in carbohydrate synthesis. According to distinct literature reviews the production of potato is restricted by using different factors, among these, insufficient application of nitrogen fertilizers, is distinguished one. Hence farmers produce potato for meals crop rain fed conditions. However, there is no a complete advice for N fertilizers. Hence, data is missing on the top of the line nitrogen fertilizer rates.

N fertilizer supply and rate drastically interacted in all vegetative increase characteristics as expressed through plant length, leaf number/plant, leaf area/plant, leaf chlorophyll content, and plant sparkling and dry weights. Nitrogen rate will increase the complete tuber number, marketable total number, total tuber yield, marketable tuber yield and average tuber weight with growing nitrogen.

The growing in wide variety of marketable with increasing in application nitrogen is associated with limit in the range of small measurement tubers due to increase in the weight of individual tubers.

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