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Review on effects of nitrogen and phosphorus fertilizers rates on yield related components and yield of potato (*Solanum tuberosum* L.)

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Abstract
Potato (*Solanum tuberosum* L.) is one of the most important food crops in the world. It is ranked in fourth following wheat, maize and rice. It is very important food and cash crop in Ethiopia. Potato can give great emphasis's as it gives highest nourishment per hectare. Absence of high yield and adaptable varieties, high susceptibility of the existing varieties for bacteria disease and poor tuber quality are the major production constraints in the area. Nitrogen and phosphorus management are perhaps the most important aspects of successful. Potato (*Solanum tuberosum* L.) Nitrogen and phosphorus fertilizers are applied in the form of P_2O_5, it is genetic potential for both nitrogen and phosphorus are important for vegetative and reproductive of potato. The main objective of this seminar is to review the effects of nitrogen and phosphorus fertilizers rates on yield related components and yield of potato (*Solanum tuberosum* L).

Keywords: Fertilizer, potato, tuber, yield

1. Introduction

1.1 Background and Justification

Potato (*Solanum tuberosum* L.) is one of the most important food crops in the world in volume of world crop production potato ranked 4th following wheat, maize and rice (FAO, 1995). Among the root and tuber crops potato ranks top followed by cassava, sweet potato and yam (Hhawkes, 1999)

Agriculture is the base of Ethiopian economy contributing over 60% of national Gross Domestic Production (GDP), 90% of the national foreign exchange earnings and 85% of the national labor force. Despite its great importance and enormous potential, agriculture has remained unproductive and people of Ethiopia faced critical food deficit. Improved production of root and tuber crops could be play a big role in densely populated areas of the country, for improving high income as well as nutritional status. Root and tuber crops are labor intensive and produce high yield per unit time and area, thus their husbandry need to be encouraged in labor abundant and capital scarce areas of the country where it could ensure ecological balance since root and tuber crops is so divers. Various root and tuber crops are produced in Ethiopia among them is potato. (Semagn, 2003) [9].

Potato (*Solanum tuberosum* L.) is very important food and cash crops in Ethiopia. It is also reliable crop during short and erratic rain fall condition. The farming system of the area mainly depend on cereals, mostly barley however, cereal production is decline year to year. Drought tolerant cereal crops are not currently available in the area. In such area therefore, new production methods and crop varieties should be adapted. Early and highly calorie giving crops should be identified and introduced. In this case potato can be given great emphasis as it gives highest nourishment per ha of all basic food staffs (ARARI, 2002).

Apart from the major constraints, farmers in the high lands face some problems for the production of potato. Absence of high yielding and adaptable varieties, high susceptibility of the existing varieties for bacterial disease, poor tuber quality and late maturity, lack of planting materials are some of the production constraints in the area

Potato production could be increased by improving the genetic potential of the crop or use of improved agronomic management like use of fertilizers. Economic motives can be a main spring for a more efficient use of fertilizers. It is not surprising that most farmers did not give much attention to the efficient use and application of fertilizers in the high lands. However, the increase in economic pressure on agriculture and the over production for several crops

moved farmers interest from maximizing the production towards product factors such as fertilizers (Semagn, 2004). In high land area the blanket recommendation of 54 N kg /ha and 138kg P_2O_5 per ha or 300 kg DAP is used in potato production in this area. The evidence that fertilizer requirement of potato, however differs depending very much on soil type, cultivars and climatic situation of the area necessitates development of proper recommendation on nutrient requirement region wise (Lema, *et al*., 1992).

Potato producer in Ethiopia conscious of the response of potato to applied nutrients and raised the crop is home stead's using farm yard manure and hose hold garbage. They do not how ever know the type and rate of fertilizers to be applied for individual cultivars for improving crop productivity. In the high lands of south wollo information pertaining to potato varieties and their interaction with nutrients relevant to tuber yield, potato yield components and other agronomic taints is rare. In this regard the studies of variety and fertilizer interactions are the most important consideration for optimizing fertilizer application rate for potato production (Abdulwahab, 2003).

1.2 Objective

The objective of this review is to assess the effects of nitrogen and phosphorus fertilizers rates on yield related components and yield of potato (*Solanum tuberosum* L.)

2. Literature Review

2.1 Effects of Nitrogen and Phosphorus on Potato (*Solanum tuberosum* L.)

2.2.1 Effects of Nitrogen in the soil and plant

The three major essential plant nutrients are nitrogen, phosphorus and potassium were found increasingly in short supply in the soil. Particularly nitrogen and phosphorus are deficient in many soil (Abdulwahab, 2003) on the other hand, indicated that potato was a heavy feeder of nitrogen and phosphorus. Quite large quantities of these nutrient elements are taken up during the course of growth. Soil type, length of growing season, soil moisture, variety, proceeding crop and other environmental factors had also a marked effect on growth and nutrient uptake of the crop (Solomon and Megersa, 2005) [10].

Nitrogen has been identified as being the most limiting nutrient in plant growth. Of the three major plant nutrients, nitrogen exerted most noticeable effects on Plants vegetative stage. It was required in the greatest quantity by most crops. It is also one of the most complexes in behavior, occurring in soil, air and water, inorganic and organic forms, for this reason it posed the most difficult problem in making fertilizer recommendations (Abera, 2001).

Improved nitrogen management is needed to optimize economic returns to farmers and minimize environmental concerns associated with agricultural N use. Nitrogen losses through leaching can contribute to elevated NO_3 concentrations in groundwater. Concerns about NO_3 leaching are particularly relevant in areas with coarse-textured soils receiving N fertilizer inputs for intensive, irrigated crop production.

Research efforts to minimize NO_3 losses to ground water on irrigated sandy soils have identified N management practices, such as NH_4–based and slow release N fertilizer sources, appropriate timing of N fertilizer applications, and the use of nitrification inhibitors that can improve N fertilizer efficiency. However, recovery of fertilizer N in the harvested portion of potatoes is usually <50% (Abdulwahab, 2003). Nitrogen remaining in crop residues after harvest represents significant N and this N can contribute significantly to the N requirement of subsequent crops. Little information is available on the fate of N in crop residues or on the influence of this N on the N fertilizer requirements of subsequent tuber on clay soils in cool, humid climates.

According to Adugna (2003) [3], citation the main forms in which nitrogen is added to the soil is as inorganic fertilizers are nitrate ($NO3^-$), ammonium ($NH4^+$) and simple amides (NH_2). Nitrogen is absolutely essential for plant growth. Ample nitrogen has attendance to encourage stem and leaf development. It encourages vegetable growth and gives green color to leaves and also increase potato faulty and production efficiency as it is observed in the greatest amount by plants.

The availability of nitrogen form can be made unavailable or lost for plant uptake, identification, volatilization, and leaching and ammonium fixation. Nitrogen is applied relatively in large quantities. The deficiency of nitrogen has un overriding control on plant growth and dominates the effect of other plant nutrients. The deficiency symptoms of nitrogen in plants generally include stunted plant growth, spindly appearance of plants, and reduced growth of leaves, chlorosis and premature senescence of older leaves and restricted root growth and branching (Abdulwahab, 2003).

Nitrogen fertilizer application on potato has been frequently increased the proportion of height. (Abdulwahab, 2003) reported that increase potato height by increasing levels of nitrogen.

2.2.2 Effects of phosphorus in the soil and plant

Phosphorus is claimed to be the second most often limiting plant nutrient. Plants absorb phosphorus in the form of HPO_4^{-2} and HPO_4^-. The physical and chemical properties of soil were reported to influence the solubilities of phosphorus and it adsorption reactions in soils. More over availability of phosphorus from fertilizers may be affected by the soil reaction and the degree of soil phosphorus deficiency (Adugna, 2003,) [3]. According to Mulubrihan (2004) [8], the original source of phosphorus is the mineral apatite. Soil microorganisms and organic matter including plant residue, animal excretion and remains are known to contribute to the phosphorus cool upon mineralization.

The use of phosphorus fertilizers becomes imperative because the concentration of phosphorus in many soils is reported to be very low and it is also liable to different chemical reactions that make it unavailable to plants (Solomon and Megersa, 2003). Plants provided with adequate amount of phosphorus fertilizer have been reported to form good root systems, strong stem, mature early and give high yield. On the other hand, plants growth, low as hoot to root, poor fruit and seed formation, purple color leaf with radish discoloration of the leaf. Biochemical phosphorus deficiency causes changes in functions of the plant including accumulation of sucrose and reducing sugars and sometimes of starch (Tekalign, 1988) [11].

2.2.3 Effects of nitrogen and phosphorus on Yield Component and yield of potato

According to (Solomon, 2005) [10] potato is an herbaceous crop which requires both phases of vegetative and reproductive proceeding in practically equal magnitude.

Yield is related to the general vegetative growth, which determines to a considerable extent reproductive growth. Yield development of potato is known to be the result of three physiological processes leading to the formation of yield components. These are stem number per plant or per unit area, tuber numbers per unit area, and average tuber weight. The sequential system of yield development of the potato involves interactions among individual yield components, in which later developing components are found to be dependent up on earlier developing ones.

The interaction of nitrogen and phosphorus were highly significantly increased total tuber yield. The positive nitrogen and phosphorus interaction expressed in total tuber yield might probably be attributed to a possible function of phosphorus in increasing nitrogen use efficiency (Semagn, 2003) [9]. This may be due to the fact that these two important nutrients have complementary physiological functions in plants. The positive effects of nitrogen and phosphorus on potato yield were positive and highly significant correlation values between total yields per/ha. The potato crop is usually propagating by using underground storage organs known as tubers. Potato tuber show a wide range of variation and possess a variable number of growing points (buds) arranged in groups over their surface and potato tubers contain two types of buds, namely apical and lateral buds (Semagn, 2003) [9].

According to (Abdulwahab, 2003), the importance of increasing the stem number per plant for increases graded and total tuber yield. There is a close relationship between the number of main stems or above ground stems, tuber yields. High stem number per plant favored, high tuber yield through effect on haulm growth and tuber number per plant. The yield development of potato as influenced by nitrogen fertilizer, observed that the yield difference due to nitrogen treatment was not attributed to its effect to on stem density as the number of stems was not significantly influenced by nitrogen nutrition. There is no significance difference in plant establishment as a result of increased application of nitrogen and phosphorus.

Nitrogen fertilizer is reported to affect yield by its effect on the tuber yield produce per plant. The average weight of tubers, the establishment and leaf area duration. The yield reduction due to excess rates of nitrogen may be explained by the fact that high amount of this nutrient stimulates shoot growth more than tuber growth which may results in deterioration of canopy structure and physiological conditions observed significant and consistent yield increment with increase in the level of nitrogen (Mulubrihan, 2004) [8].

2.2.4 Effect of Nitrogen and phosphorus on dry matter content of tuber yield

It is often necessary to know the dry matter content of potato tubers since this largely governs the weight of processed products, which can be obtained from a given weight of raw tubers. High dry matter has been reported to be desirable because of less sugar content and water accumulation reported (Semagn, 2003) [9] reduced percent of dry matter of potato tubers as nitrogen rates increased. Similar findings were reported by (Adugna, 2003) [3] high rate of nitrogen delay tuber initiation and maturity as a result tubers tend to be harvested immature with low dry matter percentages.

Regarding phosphorus (Mulubrihan, 2004) [8] reported non significance difference in dry matter contents due to increased phosphorus application. Tuber weight is the third most important yield component contributing to the total tuber yield. The growth of tuber tissue is reported to occur both by cell division as well as expansion. Cell division is more important than cell expansion for tuber growth. Tuber weight is affected by variety and growth conditions. Variation in tuber yield due to nitrogen treatments were related to the tuber weight increment. Potato yield component is mostly affected by nitrogen and phosphorus application is the mean tuber weight by extending canopy, leave area and higher supply of photosynthetic (Solomon, 2004).

2.2.5 Effects of nitrogen and phosphorus on tuber number

The main effect of nitrogen and phosphorus on total marketable and unmarketable tuber numbers per hill of nitrogen increased highly significant total tuber number per hill. Similarly increasing the level of applied phosphorus highly significantly increased total tuber number per hill. The increased in total tuber number per hill. The effect of nitrogen on total tuber number was enhanced due to the presence of phosphorus. This may probably tuber due to the fact that these two important plant nutrients have complementary metabolic and physiological functions, there by affecting the yield and yield components of the potato plant (ARARI, 1990) [4].

3. Summary and Conclusion

Potato is grown and eaten in many countries than any other crop and in the global economy it is the fourth most important crop after the three cereals wheat, maize, and rise. Though potato occupy smaller area in most developing countries than the other major food crops, their increasing population has caused planners and policy makers to take a closer look at the present and future roles that potato may play in national food production systems because potatoes are one of the most efficient crops for converting natural resources, labor and capital in to a high quality and yield more nutritious food material. Potato is also a heavy feeder and responds well to nitrogen and phosphorus fertilizer. The application of nitrogen show effect on the parameter of plant height.

Nitrogen and phosphorus plays a greate role both on vegetative and reproductive of potato. Optimum recommendation of these fertilizers are highly significant on the yield and yield components, recommendation of nitrogen and phosphorus highly depend on the soil condition and the amount of these fertilizers with in the soil. Nitrogen in the soil loses due to leaching and volatilization as a result more emphasis on nitrogen application than phosphorus is essential for the increments of yields.

4. Recommendation

There has been a considerable amount of research in the area of effects of nitrogen and phosphorus on potato yield, but the process by which tubers are formed still remain unclear. Therefore, in order to use the advantages of the new findings and already available information concerning the principles of tuber formation, stem number further research should be done in the following researchable areas.

It is not yet known nitrogen and phosphorus levels causes the formation of tuber, there for in order to use the concept of nitrogen and phosphorus supply for manipulation of tuber yield it needs further study.

Whether nitrogen or phosphorus have more important effects on tuber yield is difficult to establish from available data, so that still it needs further study.

Since field experiments on the effects of nitrogen and phosphorus on tuber formation and development have produced contradictory results, it is calling for future research works

Excessive use of nitrogen and phosphorus was reported to have deleterious effects on the number of tubers, stems and growth of the plant, the nature of these effect is not well understood, so that more research is required in order to create understanding about the nature of the effects and utilize for potato production.

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