



Growth and Fruit Yield of Tomato (*Solanum lycopersicum* L.) under Different Levels of Phosphorus Fertilization

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ABSTRACT: Having substantial and working knowledge on phosphorus fertilization is a pre-requisite to profitable tomato production. Thus, the present research was conducted to determine the optimum phosphorus (P) fertilizer rate for better fruit yield of tomato in Ilorin, a location in the Southern Guinea savannah zone of Nigeria. Five levels of phosphorus (0, 30, 60, 90 and 120kgP/ha) were tested on UC82B tomato variety. The experiment was laid out in a randomized complete block design with 3 replications. Data were collected on plant height, number of leaves, leaf area and number of branches at different growth stages while data on fruit yield as well as its components were collected at harvest. Results showed that application of 30kgP/ha produced plants with the highest leaf area. The control and 30kgP/ha produced the highest number of leaves. Application of 90kgP/ha and 120kgP/ha resulted in production of highest number of fruits while application of 90kgP/ha alone resulted in production of the tallest plants, highest number of branches and highest fruit yield. The yield was 66% better than the control. It was, therefore, concluded that 90kgP/ha should be used for optimum tomato fruit production in the agro-ecological zone of the research and places with the same climatic and edaphic conditions.

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Tomato (*Solanum lycopersicum* L) belongs to the family Solanaceae. It is a widely grown vegetable in the world because it is recognized as a rich source of vitamins and minerals. Consumption of tomato can prevent several diseases (Willcox *et al.*, 2003) because it has anti-oxidants like carotene, phenolic compounds and ascorbic acid (Periago *et al.*, 2009). Availability of tomato and other crops at all times cannot be attained without availability of essential plant nutrients (Chen, 2006; Ali *et al.*, 2008). Therefore, plant nutrients become essential components of sustainable agriculture. In the same vein, the essential nutrients must be readily available in sufficient and balanced quantities for optimum plant growth and yield. Nevertheless, suitable and balanced combinations of macro and micro nutrients should be considered not only for essentiality of crop growth and yield but also for friendliness of our environment (Chen, 2006). Crops can grow in a wide range of environments by adjusting their morphological and physiological characteristics to environmental

conditions (Lambers *et al.* 1990). Phosphorus (P) is an example of nutrient elements that may differ in availability in different environments. This nutrient element often limits plant growth (Schachtman *et al.*, 1998) especially in heavily leached soils (Raaimakers *et al.* 1995). Adequate phosphorus nutrition enhances many aspects of plant physiology including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed production) and maturation. A mineral element that has been reported to be important for fruit growth and development is phosphorus (P). Studies by the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria from 1989 to 1998 showed that phosphorus deficiency is a major yield-limiting factor in several locations in Nigeria. This results from low organic matter content and high P-fixation capacity of the soils (Mokwunye, 1999). As for tomato, Aduayi *et al.* (2002) made it clear that P is the mineral nutrient needed in largest quantity in Nigeria by tomato plant compared to other macronutrients. In the same vein,

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it has been established that when there is optimum P, much of energy required for plant metabolism which is stored chemically in the form of complex organic phosphates and adenosine triphosphate (ATP) will be made available and released as required. Therefore, important chemical processes involved in growth will be driven steadily. Despite the fact that phosphorus encourages root development and provides energy by forming ATP (Shaheen *et al.*, 2007), there is dearth of research on influence of phosphorus nutrition on tomato growth and fruit yield in the Southern Guinea savannah zone of Nigeria. Also, the use of blanket recommendation in fertilizer application which is usually the order of the day among the farmers is inappropriate. Therefore, it becomes a necessity to identify appropriate phosphorus rate for specific soil types, cultivars, regions and locations. Thus, the present research was conducted to determine optimum phosphorus (P) fertilizer rate for optimum growth and fruit yield of tomato in Ilorin, a location in the Southern Guinea savannah zone of Nigeria.

MATERIALS AND METHODS

Experimental site: The experiment was conducted at the University of Ilorin Teaching and Research Farm. The University is located between Latitude 8° 29'E & 8°30'E N and Longitude 4° 30'E & 4° 32'E). The location is about 307m above the sea level in the Southern Guinea savannah ecological zone of Nigeria.

Soil sampling, testing and field preparation: Soil samples of the experimental plot were taken using systemic sampling. The samples were taken from the top 0-15cm and bulked together to get a composite sample. The composite sample was then air dried for 5 days, sieved through a 2mm sieve and analysed for both physical and chemical properties (Table 1). The land used was ploughed, harrowed, and ridged. Beside the experimental plot was a nursery bed for raising tomato seedlings. The bed was located as such to ease transplanting.

Planting materials and nursery establishment: Tomato seeds of variety UC82B packed by the Premier Seeds Nigeria Limited were used in this experiment. The seeds were planted using broadcasting method to have enough number of seedling while transplanting. The bed was well irrigated before sowing. Subsequently, the bed was irrigated on a regular basis till the seedlings were ready for transplanting. Shade was provided to protect the seedlings from high insolation and heavy down pour.

Field establishment, treatments and cultural practices: Healthy and uniform seedlings were

transplanted to the field when they were five weeks old. The size of the field was 3m by 3m. Plant spacing was 60 by 120cm. The field was laid out in randomized complete block design with three replications. Two weeks after transplanting, five levels of P fertilizer (0, 30, 60, 90 and 120kg/ha) in form of single superphosphate (SSP) were tested on the plants. Weed control was done manually with the use of hoe. The first weeding was at 3 weeks after transplanting (WAT) while the second one was at 6WAT.

Data collection and analysis: At 4 weeks after transplanting (WAT), three representative plants were selected at the middle row of each plot and tagged for observation and data collection throughout the experimental period. Plant height measured from the base of the plant stem above the ground to the last expanded leaf tip using a tape rule. The number of branches, leaves and fruits were manually counted while leaf area was determined using graphical method (Sestak, 1971). At harvest, the fruit yield per hectare was determined at harvest. All the data collected were analysed using analysis of variance with the aid of Genstat 5.2 and significant means were separated using least significant difference (LSD) at 5% probability level.

Table 1: Physical and chemical properties of the field soil used

Parameters	Values
pH(water)	6.20
P(mg/kg)	1.20
Ca (Cmol/kg)	1.40
K (Cmol/kg)	1.80
Mg (Cmol/kg)	0.90
Na (Cmol/kg)	1.20
N(g/kg)	0.05
Sand (%)	83.52
Silt (%)	8.00
Clay (%)	8.48
Soil textural class	Loam

RESULTS AND DISCUSSION

The P effect on plant height was different from that of the control only when the rate of application reached 90kg/ha single super phosphate (SSP) and it was consistent throughout the period of observation and data collection. At the last stage of data collection, the tallest plants were still from plots treated with 90kg/ha SSP while the shortest plants were from plots treated with 30kg/ha SSP (Figure 1). Production of the tallest plants with the application of 90kg/ha SSP could have resulted from increase in metabolic activities of the plant for which is the function of phosphorus nutrition. It might also be that application of 90kg/ha SSP aided mitotic division of the shoot apical meristem and that led to better increase in height than the other application rates. Arora *et al.*(1994) lent credence to this observation through finding significant

improvement in plant height and fruit size with application of 0-90kg /ha phosphorus fertilizer.

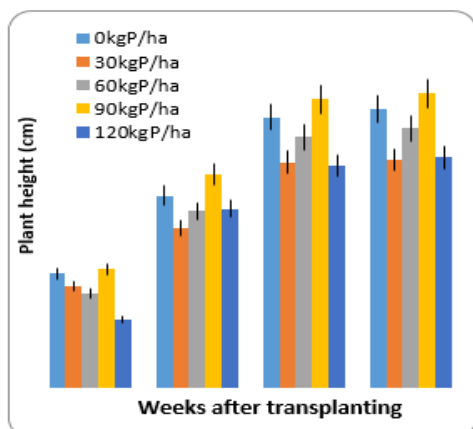


Fig 1: Effect of phosphorus fertilizer on plant height at different ages: The vertical line on each bar in the graph represents a standard error bar

There was a linear increase in the trend of leaf production from 4th to 10th week after transplanting. However, leaf production from the control plants was the same with that of 30kg/ha SSP treated plants at 10th week after transplanting. The highest number of leaves was produced by both the control and 30kg/ha SSP treated plants. 0kgP/ha and 30kg/ha SSP treated plants were 49.18% better than 120kg/ha SSP treated plants (Figure 2).

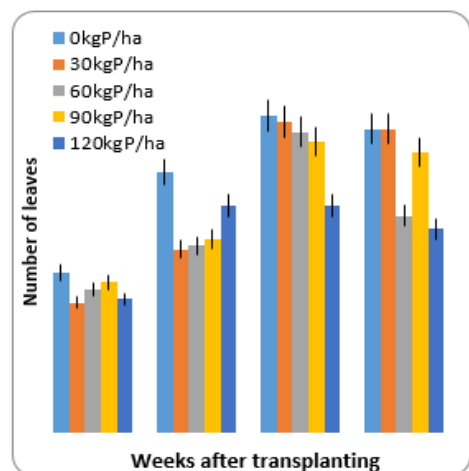


Fig 2: Effect of phosphorus fertilizer on number of leaves per plant at different ages. The vertical line on each bar in the graph represents a standard error bar.

The linear relationship of leaf production with passage of time for all the levels of P fertilizer application which witnessed a decline at the last stage might be the result of adversity of weather (water deficit) which

hampered the release of P for plant use. It could equally be due to variations in plant vigour and senescence of leaf caused by low water intake by plants and high temperature. It has been established that when development is depressed by adverse factors such as water deficiency or soil temperature, growth and development might not occur (Alonso-Blanco *et al.*, 2009). The response of branch production to P fertilizer was less than that of the control except for 90kg/ha SSP application which was finally on the par with the control. Although the branches increased as the time passed by, the response was as if no additional nutrient was added (Figure 3).

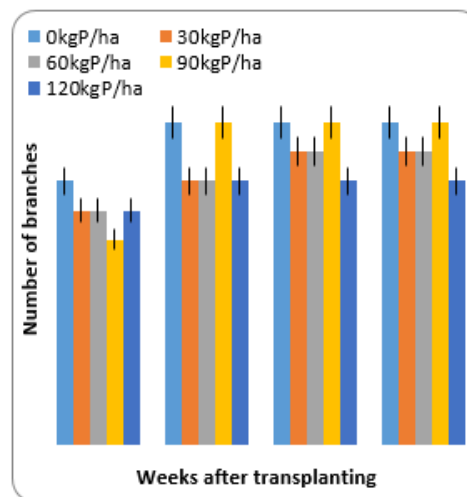


Fig 3: Effect of phosphorus fertilizer on number of branches per plant at different ages. The vertical line on each bar in the graph represents a standard error bar.

The control plots produced the highest number of branches. This could have resulted from optimum nitrogen supply of phosphorus from the soil because phosphorus is the one responsible for general vegetative growth of which branch production is a part. Despite this observation, researchers like El-maziny *et al.*,1990, Naik and Srinivas (1992) as well as Bhat and Dhar (1999) upheld that increase in fruit length and number of branches were direct result of very high rate of phosphorus fertilizer application. Tomato leaf area also increased with passage of time with the least found from plants treated with 120kg/ha SSP. At the final stage, the largest leaf area was found in 30kg/ha SSP treated plants while the least was from the control. All the phosphorus treatments were better than the control (Figure 4). The leaf area was partially affected by the phosphorus fertilizer application because leaf area increased with increase in fertilizer levels. This result may be attributed to beneficial effect of phosphorus on cell division and formation of carbohydrates. However, increasing rate of applied

phosphorus fertilizer may increase production costs and result in environmental pollution.

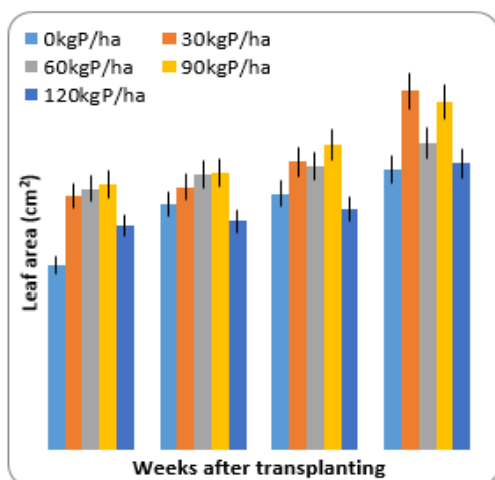


Fig 4: Effect of phosphorus fertilizer on tomato leaf area per plant (cm²) at different ages. The vertical line on each bar in the graph represents a standard error bar.

At 10weeks after transplanting, there was a change in the trend of leaf area development which may be caused by adverse weather and edaphic condition such as high soil temperature. The causes of observed changes as well as purpling and premature senescence are associated with certain external and internal factors in the plants (Alonso-Blanco *et al.*, 2009). Fruit production per plant was better with application of 90 and 120kg/ha SSP while the rest treatments were the same (Figure 5).

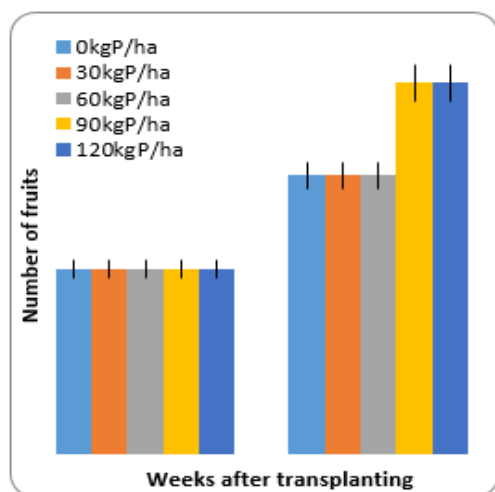


Fig 5: Effect of phosphorus fertilizer on number of fruits per plant at different ages. The vertical line on each bar in the graph represents a standard error bar.

The highest number of fruits was produced by application of 120kg/ha SSP while the lowest number of fruits was produced with application of 60kgP/ha. Therefore, the positive effect of phosphorus fertilizer on vegetative growth and its components previously discussed surely reflected on number of fruits produced. This implies that phosphorus supplementation could significantly improve the vegetative growth of tomatoes as well as number of fruits per plant (Moustafa *et al.*, 2005). Fruit yield was enhanced by application of phosphorus fertilizer. 90kg/ha SSP application had the highest yield while the control had the lowest. Application of 90kg/ha SSP was 66% better than the control in fruit production (Figure 6).

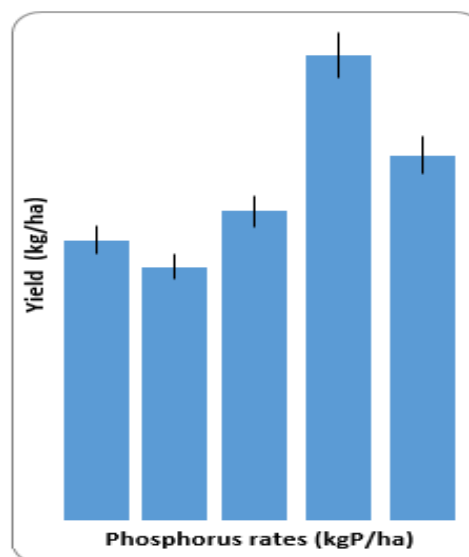


Fig 5: Effect of phosphorus fertilization on fruit yield of tomato

The highest yield per hectare was realized from application of 90kg of phosphorus per hectare. So, addition of phosphorus fertilizer could result in significant increase in fresh and dry masses of tomato as it also occurred in maize plants (Mehalla *et al.*, 2004). Furthermore, phosphorus improves germination percentage, blooming, fruit setting, seed fertility and fruit yield. These might be the result of positive effect of phosphorus on plant metabolic processes which include cell division, formation, expansion and carbohydrate movement (Marschner, 1995)

Conclusion: From this work, it was found that application of P fertilizers (SSP) up to 90kg/ha increased fruit yield. Therefore, optimum fruit yield in UC82B tomato cultivar could be achieved with application of 90kg/ha SSP in the Southern Guinea

savannah agro-ecological zone and places with the same climatic and edaphic conditions.

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