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The Effect of Different Levels of Phosphorus on Growth and Yield of Onion (*Allium cepa* L.)

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Abstract

A field experiment was under taken to study the effect of different levels of phosphorous on growth and yield of onion (*Alluim cepa* L.) var.Adama red in South West of Ethiopia, JUCAVM (Horticultural garden) during 2014 under irrigation condition. Onion is the most essential vegetable for nutritional and economical purpose. But there was low yield and production difference like under farmer's field between 9 to 15 t $^{ha-1}$ which was far less than under research area which was 30 to 35 t $^{ha-1}$. Therefore four rates of phosphorous (0, 60, 90 and 120 kg $^{ha-1}$) was arranged in a Randomized Complete Block Design (RCBD) and replicated three times to study the effect of different levels of Phosphorous on growth and yield of onion. The size of the total plot is 3.7m by 4.8m (17.76m^2) and the size of each plot is 0.9m X 0.9m (0.81m^2). Phosphorous showed significant and non-significant difference on growth and quality parameters but shows significantly difference on yield parameter of onion. Plant height was observed significant difference at four levels of Phosphorous. Maximum leaf diameter and number of root was observed at 90 kg and 120 kg of phosphorous than control and 60 kg of P_2O_5. But had no significant difference on leaf number from growth parameter. Like that maximum bulb diameter, fresh bulb weight and dry bulb weight was recorded at 60, 90 and 120kg $^{ha-1}$ than control. But vertical bulb thickness had non-significant on each phosphorous levels. By considering cost of production 60kg P $^{ha-1}$ level was recommended from all significant difference Para meters.

Keywords: onion, yield, phosphorous, bulb

1. Introduction

Onions (*Allium cepa L.*) are biennial herbaceous members of the family Alliaceae that are typically grown as annuals (Gebremeskel et al., 2016). It belongs to the genus Allium which contains 300 species which widely distributed in northern temperate region. They are native to southern Asia and Ural mountains and have long been valued in china and India for their flavorings (Kamenetsky, 2007). Globally, onion is produced at nearly 35 million tons per annum (FAO, 2005). In Ethiopia onion is widely grown in the rift valley and lakes region of the country (Lemma and Shimeles, 2003). The total area under onion in Ethiopia was estimated to be 15628.4 ha with total production of (0.148 Mt), in the year 2008 with an average of 7.9t/ha (CSA, 2009).

Onions are cool season crop adapted to wide range of temperature and can withstand short exposure to temperature well below freezing. Optimal production is obtained when cool temperatures (55 to 77 ^{o} F). They are gown on much too heavy clays. Onion plants is sensitive to high acidity and produces maximum yield over fairly narrow ranges of soil reaction on sandy loam soil on long island reported that maximum of onion produced at PH 5.8-6.5 (Halliburton, 1996).

Onion is one of the most important condiments, being widely used in green form or as mature bulb or both salad and for preparation of a number of dishes like soups, sauces and for seasoning of foods Mild flavored or colorful bulb onions are often chosen for salads (Gebeyehu, 2018). Varieties with high total soluble solutes (TSS) content are convenient for processing in the form of dehydrated slices. Consumer often has very strong local preferences for size, shape and pungency bulb of onion (Rabinowitch, 1994). The productivity of onion in farmers field ranges between 9 and 15 t/ha which is far less than the yield obtained under research area which is 30-35 t/ha (Solomon, 2018). These can be due to many factors. The most important factors are lack of optimum levels of phosphorus fertilizers (Abdisa *et al*, 2011).

Phosphorus fertilizer is one the most complex in production in many tropical soils, owing to low native content and high phosphorus immobilization with in the soil. Phosphorus is essential for root development when availability is limited, plant growth is usually reduced. In onion, phosphorus deficiencies reduced root and leaf growth, bulb size and yield and also delay maturation (Abdisa *et al*, 2011). In the soils that are moderately low in phosphorus, onion growth and yield can be enhanced by applying phosphorus .Onions are more susceptible to nutrient deficiencies than most crop plants because of their shallow and un branched root system, hence they require and often respond well to addition of fertilizer (Khokhar, 2019).

Onion is grown in most parts of Ethiopia but, a lot of constraints have contributed to the low yield. Phosphorus deficiency is one of the constraints to onion production in many tropical soils (Balemi & Negisho, 2012). The use of sub optimal phosphorus fertilizer is one of the prominent to mention. Still well recommendation rate of phosphorus fertilizer is not well identified. So farmers get low yield and poor quality of onion. To this effect, this research was initiated to determine appropriate rate of phosphorus on growth and yield of onion. Therefore the objective of these study were to determine the effect of different level of phosphorus on onion growth and yield as well as to recommend the appropriate level of phosphorus fertilizer on onion growth and yield for the growers.

2. Materials and Methods

2.1 Experimental Location

The experiment was conducted at Jimma university college of Agriculture and Veterinary Medicine (JUCAVM) in 2014 under field condition and irrigation. JUCAVM was geographically located 346 km south west of Addis Ababa at about 7^{o}, 33N latitude and 36^{o}, 57'E longitude at an altitude of 1710m.a.s.l. The mean maximum and minimum temperature were 28.8^{o}c and 11.4^{o}c respectively and the mean maximum and minimum relative humidity were 91.4% and 39.92% respectively. The mean rain fall of the area was 1500mm. The soil of the experimental site was characteristically reddish brown clay soil with PH ranges from 5.07 to 6.0 (Negash et al., 2018).

2.2 Experimental Design and Treatment

The treatment used consists of four levels of phosphorous (0, 60, 90,120kg P_2O_5/ha) arranged in randomized complete block design (RCBD) with three replications. Spacing of 15cm both between rows and plants were used. Each plot had an area of $0.81m^2$ (0.9m length and 0.9m width) and the spacing between block is 0.5 m and spacing between plot is 0.4m. The total area covered by the plots is $17.76m^2$.

2.3 Experimental Procedure

The experimental field with flat slope was selected and cleaned. The field (experimental area) was tilled three times, pulverized and softened by application of water. The land layout was taken and measured accurately by using Pythagoras theorem in the rectangular form with the total area of $17.76m^2$. The land was divided into twelve plots which had four treatments and three replications. Phosphorus fertilizers were incorporated to soil during the onion seedling planted.

Onion seedling was planted at 15*15 cm spacing in the each plot. Thirty six seedlings of onions were planted per plot and total numbers of seedlings planted were 432. Watering and other cultural practices were conducted according to their recommendation. Other cultural practice like weeding, cultivating and fertilizing were carried out properly.

2.4 Data Collection

Data collections on growth parameters (plant height, number of root per plant, number of leaf per plant and diameter of leaf plants) were taken at vegetative growth except number of roots per plant that was taken at harvesting time. Quality and yield parameters at harvesting time of bulb were also collected on (diameter of bulb, vertical bulb thickness) and (fresh bulb weight, dry bulb weight) respectively.

2.4.1 Growth parameters

In order to evaluate onion growth parameters that will be collected different levels of phosphorus fertilizer the following data will be listed as follows: .

Number of leaves per plant: Starting from fourth week after transplanting number of leaf per plant was counted by taking three plants from each plot.

Diameter of leaves: Leaf diameter was measured using ruler by taking three plants from each plot at the widest point of the third youngest leaf.

Plant height: Plant height was measured from soil surface to the top of the longest leaf by using ruler.
Number of root per plant: Number of root per plant was recorded by counting number of root on each individual plant using hand

2.4.2 Quality components

Diameter of bulb: Bulb diameter was measured at harvesting time by using vemier caliper at the widest point in the middle portion of the maturated bulb.

Vertical bulb thickness: Vertical bulb thicknesses of the three plants from each plot were measured at harvesting time using a vemier caliper from the bottom to the top of the matured bulb.

2.4.3 Yield components

Fresh weight: Fresh bulb weight was measured by taking three plants from each plot and weighed using sensitive balance at the time of harvest.

Dry weight: For determination of dry bulb weight also three plants from each plot were taken and oven dried at temperature of 80^{o}c for 48 hours. Then weight was measured using sensitive balance.

2.5 Statistical Analysis

All data collected were subjected to analysis of variance by statistical procedures as described by Gomez (1984) and means were compared using least significance difference (LSD) at 5% probability level and SAS software was used for the analysis.

3. Results

3.1 Growth parameters

The growth of onion was influenced by different levels of phosphorus fertilizer. After data analysis the result of our study indicated that phosphorus has significant effect on some growth parameters (plant height, leaf diameter and root number) and has non-significant effect on other growth parameters (number of leaf). This is indicated in (Table 1) below.

Table 1. Effect of different levels of phosphorus fertilizer on height of plant, number of leaf, diameter of leaf and number of root.

Phosphorus (kg ha^{-1})	Plant height (cm)	Number of leaf	Leaf diameter(mm)	Number of root
120	54.90^{a}	13.667 ^{Ns}	16.20^{a}	132.66^{a}
90	50.86^{b}	22.333 ^{Ns}	16.36^{a}	126.00^{a}
60	46.26^{c}	27.333 ^{Ns}	12.90^{b}	113.00^{b}
0	41.20^{d}	9.667 ^{Ns}	8.30^{c}	72.33^{c}
LSD (5%)	3.66	21.62	2.94	10.29
CV (%)	3.789	59.297	10.948	4.642

Means followed by the same letter are not statistically significant different at α =5%.
Ns: non significant, CV: coefficient of variance and LSD: least significant difference at α=5%.

3.2 Quality Parameters

Quality of onion was influenced by applying different doses of phosphorus fertilizer have significant difference (diameter of bulb) and have no significant difference (vertical thickness of bulb). This can be indicated (Table 2) below.

Table 2. Effects of different levels phosphorus fertilizer on quality of onion.

Phosphorus (kg ha^{-1})	bulb diameter(mm)	Vertical bulb thickness(mm)
120	45^{a}	37.13^{NS}
90	42.80^{a}	36.56^{NS}
60	44.33^{a}	37.76^{NS}
0	30.86^{b}	30.533^{NS}
LSD (5%)	5.34	11.18
CV (%)	6.55	15.77

Means followed by the same letter have no significance difference at 5% probability level NS: non significant, LSD: least significant difference, CV: Coefficient of variance

3.3 Yield Parameters

Yield of onion was influenced by applying different doses of phosphorus fertilizer and some yield parameters have significant difference (fresh bulb weight and dry bulb weight).

Table 3. Effects of different levels phosphorus fertilizer on yield of onion.

Phosphorus (kg ha^{-1})	Fresh bulb weight(g)	Dry bulb weight(g)
120	38.16^{a}	10.00^{a}
90	33.33^{a}	9.167^{a}
60	38.30^{a}	11.30^{a}
0	17.43^{b}	5.000^{b}
LSD (5%)	11.44	3.91
CV (%)	18.011	22.107

Means followed by the same letter have no significance difference at 5% probability level
LSD: least significant difference, CV: Coefficient of variance

4. Discussion

4.1. Growth parameters

4.1.1. Plant Height

The result from (Table 1) revealed that different phosphorus fertilizer levels significantly affect plant height. Maximum plant height (54.90cm, 50.86cm, 46.26cm and 41.20cm) was noted in plots applied with phosphorus at the rate of (120, 90, 60 and 0 P_2O_5kg ha^{-1} 0kg) respectively. Based on the result of the levels of phosphorous (120, 90, 60 and 0kg P_2o_5 /ha), there was significant difference observed, plant height showed an increase with increasing levels of phosphorus fertilizer. This could be due to the fact that phosphorus is essential component of the energy transfer components (ATP and other nucleic proteins, genetic information system and cell membranes that result to rapid plant growth (Waraich et al., 2011)).

4.1.2. Number of Leaf

As can be observed from (Table 1) above, the result showed that there is non-significant (P>0.05) difference between different phosphorus levels (0, 60, 90 and 120 kg P_2O_5 ha^{-1}) on onion with respect to number of leaf at 5% probability level. Even though statically non-significant difference there is some differences of mean between each four treatments.

4.1.3. Diameter of Leaf

As observed from data analyzed in (Table1) above, the result showed that there were significance difference among different phosphorus nutrition rate. Maximum leaf diameter (16.20 and 16.36) was observed in plots treated by phosphorus at the rate of 120 and 90 kg P_2O_5 ha^{-1} respectively. But, minimum diameter of leaf (12.90mm and 8.30mm) was observed in 60 kg P_2O_5 and control (no phosphorous) respectively. The reason is that phosphorus encourages plant growth, because phosphorus is an essential element. Particularly, phosphorus is a major building block of DNA molecules (Mogren*et al.*, 2007).

4.1.4 Number of Root per Plant

From the results reviewed in (Table1), it was evident that different phosphorus fertilizer levels have significant difference on number of roots per plant of onion. The result recorded indicated that different levels of phosphorus fertilizer rate (120 and 90 P_2O_5 kg ha^{-1}) with 132.66 and 126 respectively have significant difference on number of roots per plant of onion at 5% probability level than minimum number of root of (113) and (72.33) was observed in 60 kg P_2O_5 and control (no phosphorous) respectively. The reason is that addition of phosphorus fertilizer insures that crops will reach their full potential by using additional phosphorous, to encourage root growth and promoting resistances to root diseases (Brady et al., 2008)

4.2. Quality Parameter

4.2.1. Bulb Diameter

The result of our study revealed that a different level of phosphorus fertilizer (120, 90, and 60 P_2O_5kg ha-1) with 45, 42.80, and 44.33mm respectively has significant difference on bulb diameter of onion (Table 2), at 5% probability level. Minimum bulb diameter of (30.86mm) was observed in the control (no phosphorous). These are due to that increasing phosphorus application increased bulb weight and size (Vechhani and Patel, 1993).

4.2.2. Vertical Bulb Thickness

According to the results regard on quality of onion in (Table 2) above, different phosphorus fertilizer levels had non-significant (P>0.05) effect on vertical bulb thickness of onion. Interpretation result indicated that four levels of phosphorus (120, 90, 60 and 0 kg P_2O_5) have no significant difference at 5% probability level. Even though statically no significantly difference, there are some differences among mean separation of each four treatments. But the vertical bulb thickness was increased at the three levels of phosphorus fertilizer than control. The reason is according to Shaheen *et al.*, (2007) revealed that phosphorus on indispensable role in energy metabolism, the high energy hydrolysis phosphate and various organic phosphate bonds being used to induce chemical reaction Phosphorus is essential for process of photosynthesis and maturation which result to vertical bulb thickness (Brady et al., 2008).

4.3. Yield Parameters

4.3.1. Fresh Bulb Weight

Data analysis from (Table 3) above indicated that phosphorous fertilizer levels had significant effect on fresh bulb weight of onion. Maximum fresh bulb weight was recorded in the plots applied phosphorous fertilizer levels at (120, 90 and 60kg $P_2O_5ha^{-1}$ than controlled or zero P_2O_5 ha^{-1}) which was (38.16, 33.33, 38.3 and17.43g) in mean weight respectively. Fairhust *et al*, (1999) states that phosphorous was essential for root growth which results to absorption of water and other nutrient which in turn results to increase in fresh bulb weight.

4.3.2. Dry Bulb Weight

From the analyzed of data in (Table 3), it was clearly observed that different levels of phosphorous have significant difference on dry bulb weight. Maximum dry bulb weight was obtained when the fertilizer was applied at the rate of 120, 90 and 60kg P_2O_5 ha^{-1} than controlled one. This is difference due to the reason that; Application of phosphorus level positively increases and significantly affects bulb length, bulb diameter, average bulb weight, bulb dry matter

content, marketable yield and total bulb yield (Aster, 2009). Therefore phosphorous fertilizer at the rates of 120, 90 and 60kgha^{-1} can increase dry bulb weight in the mean bulb of (10.00, 9.16 and 11.30g) than controlled one which is 5.00g.

4. Summary and Conclusion

Generally, onion (*Allium cepa*. L) var. Adama red is one of the main cool season vegetable crops that largely grown for different purposes like daily human diet, as salads and for preparation of various dishes like soups, sauces and seasoning of food. The productions of onion vary from year to year and become decreasing. The main problem for these is that lack optimum level fertilizer mainly phosphorus fertilizer.Optimum level phosphorus fertilizer is essential for energy transfer, genetic information system, cell membranes, enhancement of photosynthesis. Phosphorus has great effect on growth and yield of onion. Addition of phosphorus affects number leaves, diameter of leaves, spread of plant and plant height. Like that it also affects number of root per plant, bulb diameter, vertical bulb thickness, fresh bulb weight and dry bulb weight of onion.

From these study it was observed that there is no optimum level of phosphorus. As a result field experiment was under taken by plant science students in JUCAVM garden and optimum level of phosphorus was observed on growth and yield of onion. Phosphorus at levels of (controlled, 60, 90 and 120 kg /ha) was used with three replication. After data was collected from each different treatment, the result indicated that phosphorus fertilizer had significant difference on growth of onion like, number of root, leaf diameter and plant height from stated that the maximum number of root, leaf diameter and plant height was obtained at (120,90 and 60 kg /haP_2O_5) level than controlled (0 kg /haP_2O_5). It was clearly showed that there was no significance difference among the three levels of phosphorus levels on leaf number, but it was greater than controlled one.

From quality parameter it was observed that there was non significance (P>0.05) difference among phosphorus fertilized on vertical bulb thickness. But it was greater than controlled one. Data analysis also indicated that phosphorus fertilizer had significance difference on diameter of bulb was obtained at (120, 90 and 60 kg /haP_2O_5) than controlled level.

Data analysis indicated that phosphorus fertilizer had significance difference on yield parameters like fresh bulb weight and dry weight was obtained at (120, 90 and 60 kg /haP_2O_5) than controlled level. Maximum fresh bulb weight and dry bulb weight was obtained at 120, 90 and 60 kg /haP2O_5 than 0 kg /ha P_2O_5 levels. From this level there was non significance (P>0.05)difference between 120, 90 and 60 kg /ha P_2O_5 level. By considering cost of production at 60 kg /haP_2O_5 level was recommended on growth and yield of onion.

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6. References

Abdissa, Y., Tekalign, T., & Pant, L. M. (2011). Growth, bulb yield and quality of onion (*Allium cepa* L.) as influenced by nitrogen and phosphorus fertilization on vertisol I. growth attributes, biomass production and bulb yield. *African Journal of Agricultural Research*, *6*(14), 3252-3258.

Aster Korea, (2009). Effect of nitrogen and phosphorous fertilizers on yield and yield Component of Onion (Allium cepa, L.) at M elkassa, central rift valley of Ethiopia, Pp: 109 Bsawas, T.D., and S.K. Mukherjee, 1993. Text book of Soil Science (5th Ed). Tata Mac Grow-Hall, New Delhi. 170-197.

Balemi, T., & Negisho, K. (2012). Management of soil phosphorus and plant adaptation mechanisms to phosphorus stress for sustainable crop production: a review. *Journal of soil science and plant nutrition*, *12*(3), 547-562.

Brady, N. C., Weil, R. R., & Weil, R. R. (2008). *The nature and properties of soils* (Vol. 13, pp. 662-710). Upper Saddle River, NJ: Prentice Hall.

Etana, M. B., Aga, M. C., & Fufa, B. O. (2019). Major onion (*Allium cepa* L.) production challenges in Ethiopia: A review. *J. Biol. Agric. Healthc*, *9*, 42-47.

Gebeyehu, S. A. (2018) Response of Phosphorus fertilizer rate on Growth, Yield and Yield Components of Onion (*Allium cepa* L.) at East Gojjam Zone, North Western Ethiopia.

Gebremeskel, H., Abebe, H., Jaleto, K., & Biratu, W. (2016). Genotypic Difference in Growth and Yield Related Traits of Onion (*Allium Cepa* L.) Varieties at Southern Tigray. *Current Research in Agricultural Sciences*, *3*(2), 16-21.

Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*. John Wiley & Sons.

Halliburton, T.H, (1996).The effect of soil acidity and related factors on the growth of Onions oblong ISL and, Cornell University.

Kamenetsky, R. (2007). Garlic: botany and horticulture. *Horticultural Reviews-westport then new york-*, *33*, 123.

Khokhar, K. M. (2019). Mineral nutrient management for onion bulb crops–a review. *The Journal of Horticultural Science and Biotechnology*, *94*(6), 703-717.

Mogren, L. M., Olsson, M. E., & Gertsson, U. E. (2007). Effects of cultivar, lifting time and nitrogen fertiliser level on quercetin content in onion (*Allium cepa* L.) at lifting. *Journal of the Science of Food and Agriculture*, *87*(3), 470-476.

Negash, A., Tulu, S., & Getachew, E. (2018). Yield and yield components of Snap Bean (*Phaseolus vulgaris* L.) as affected by N and P fertilizer rates at Jimma, southwestern Ethiopia. *Advances in Crop Science and Technology*, *6*(3), 3-7.

Rabinowitch, H. D. (1994). Breeding alliaceous crops for pest resistance. In *I International Symposium on Edible Alliaceae 433* (pp. 223-246).

Shaheen, A.M,M.Mona, M.Abdel, A.M.Aisha, A.R.Fatma, 2007. Natural and chemical Phosphorus fertilizers as affected onion plant growth, bulb yield and its some Physical and chemical properties Australia journal of basic and applied science, Inset publication .1(4): 519- 524.

Solomon, A, G (2018). Response of Phosphorus fertilizer rate on Growth, Yield and Yield Components of Onion (*Allium cepa* L.) at East Gojjam Zone, North Western Ethiopia. Acad. Res. J. Agri. Sci. Res. 6(9): 520-525

Vechhani, M.U. and Z.G.Petal.1996.Growth and yield of Onion (*Allium cepa*.L,)as Influenced by levels of nitrogen, phosphorous and potash under growth Gujarat conditions. Progressive Horticulture -25(4):33-46.

Waraich, E. A., Ahmad, R., & Ashraf, M. Y. (2011). Role of mineral nutrition in alleviation of drought stress in plants. *Australian Journal of Crop Science*, *5*(6), 764-777.

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