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Effect of Nitrogen Fertilizer & Poultry Manure on the Yield and Yield Components of Onion (*Allium cepa* L.) in Alage, East Shewa, Ethiopia

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Abstract: This field experiment was conducted to evaluate the effects of different levels of poultry manure and inorganic nitrogen (N) source on the yield and yield components of onion (Alium cepa L.). The treatments were four levels of poultry manure (0, 10, 20, 30t/ha) and four levels of inorganic sources of N fertilizers (0, 70, 80, 90kg/ha) was applied uniformly 16 treatments and one absolute control in a factorial randomized complete block design with three replications. The organic and inorganic sources of nutrients significantly affected most of the yield and yield parameters. Accordingly, plant height, leaf number, leaf length, leaf weight, root weight, total bulb weight, mean bulb weight, bulb diameter, harvesting index, and dry bulb weight were significantly influenced by poultry manure, and plant height, leaf number, leaf length, leaf weight, root weight, total bulb weight, mean bulb weight, bulb diameter, harvesting index, and dry bulb weight were significantly affected by the N fertilizer. Combined use of 20t/ha poultry manure and 80kg N/ha significantly improved most of the yield and yield components of the onion. Highest TBW (20.57t/ha) was also obtained from plots receiving 20t/ha manure and 80kgN while the least TBW was obtained from the control plot and the rate near to it. Most of the yield related parameters were positively correlated with MBW and TBW. However, this one season study has to be conducted across seasons and locations of similar agro-ecology, soil type and crop management in order to draw firm conclusions and make final recommendation.

Keywords: Onion, Yield, Nitrogen

1. Introduction

1.1. Background

Agriculture is the backbone of Ethiopian economy, contributing 45% share in the gross domestic product (GDP) [6]. In Ethiopia about 85% of the population is engaged in agriculture; about 75% of the Ethiopia's industry is engaged in processing of farm products [6].

Although much of the Ethiopia population, living in the rural area, is engaged in agricultural production, the agricultural productivity is low due to the use of low level of improved agricultural technologies. Moreover, due to the ever increasing population pressure, the land holding per household is declining results in low level of production to meet the consumption requirement of the households [6].

According to Bekalo and Bangay, [6] the Ethiopian agriculture over the last three decades has been unable to produce sufficient quantities to feed the country's rapidly growing human population. To ensure food security, the country needs to improve its agriculture in sustainable manner.

Human health and the surrounding environment are damaged and polluted by the misuse/overuse of fertilizers which violates the sustainability of ecosystem [17]. So, the farming system need to be in a position to fill the gaps of chemical based farming system. The maximum yield can be achieved by integrated uses of organic manure and chemical fertilizers.

According to [35] solo application of each of the fertilizers could not bring satisfactory results in the agricultural production. Because, use of chemical fertilizers along with organic manure gives a soil rich in nutrients with good physical and microbiological properties and increases cation retention and improves nutrient availability which increase the availability of nutrients [17].

In most irrigable lands, vegetable crops play an important role in contributing to the household food security. The vegetable being cash crop with nutritional value generate income for the poor households. Higher profits can be achieved by increasing the production of a particular vegetable throughout the year. Horticultural production is usually money spinning as compared to staple crops. The production of vegetable has a comparative advantage particularly under conditions where arable land is scarce, labor is abundant and markets are accessible [22].

Vegetable crops are known in their vitamins, carbohydrates and other nutrients content that contribute to a major portion to an Ethiopian daily food. Some nutritional deficiencies like vitamin A and C, and iron can be corrected by using selected vegetables. Furthermore vegetables generate foreign currency earnings in the country [19].

Onion (Allium cepa) is one of the most important vegetable crops produced in Ethiopia. It is the most widely used cash crop by the farmers in the rift valley areas of Ethiopia [6]. It can be grown on a wide variety of soils ranging from light textured sandy or sandy- loam to heavier clay soils. The soil should be rich in nutrient and organic matter. The ideal soil pH should be near neutral but never below 6.0 [31]. Soil nutrients play an important role in increasing productivity of plants and quality of the yield. Research has shown that onion is a heavy nutrient feeder and, it is a highly nutrient-responsive crop [23], and it is recognized that low soil fertility; particularly N and P deficiencies are among the major biophysical constraints affecting agriculture in Sub-Saharan Africa [20]. The major factors determining the level of soil fertility are organic matter content, availability of major and micro-nutrients, soil reaction and the physical properties such as texture, structure, depth and nature of soil profile.

Its production is enhanced by organic farming which is preferred indifferent angle. Among the organic fertilizer poultry manure is the most nutritive type of fertilizer; According to Buys [7] poultry manure affects plant production directly or indirectly by supplying important nutrients for the plant and/or by improving the soil physical, chemical and chemical properties. Poultry manure plays a great role in the productivity of any crops like onion, cereals and vegetables.

1.2. Objective of the Study

The general objective of this study is to evaluate the effect of poultry manure in combination with inorganic/commercial fertilizers on yield and yield components of onion crop.

2. Methodology

2.1. Description of the Study Area

The study was conducted at Alage Agricultural Technical and Vocational Training College (ATVETC) covering a total area of 2934 ha. Geographically, the College lies at an altitude ranging from 1600 to 1630 meters above sea level (masl) in the plateaus of the South Western part of the Ethiopian Rift Valley System.

The College is located at 218 kms south of Addis Ababa city and 32km west of Bulbula town in the vicinity of Abdijata and Shalla Lakes. Previously named as Hitsanat Amba, the college covers an area constituting four different campuses 3-5killometres apart from each other, and each could accommodate from 800-1000 trainees at a time.

Alage is characterized by a bimodal rainfall pattern where short rainy season occurs during the months of March and April and the main rain starts in June and extends to September. Very high amount of rainfall is observed in the months of July and August. The mean annual rain fall is 800mm and the annual mean maximum and minimum temperatures are 29.0 and 11.0°C, respectively. Based on the climatic data of the area reported by [9], the climate of the area is categorized as semi-arid ecological zone with ustic moisture regime.

Soils of the area are derived from basalt, ignibrite, lava, volcanic ash, pumice, reverine, and lacustrine alluvium parent materials (EG- MOA, 1975). Andosol is the predominant soil in the rift valley area of the country [39, 22, 10].

The general features of the volcanic ash soils in the rift valley of Ethiopia are relatively young with very distinctive properties developed from pyroclastic materials, notably pumice [9]. The existence of a pronounced dry season with high temperature, high fluctuating annual precipitation and ustic soil moisture regime have led to the formation of sandy loam surface texture. However, those soils refreshed by new volcanic ash deposits contained abundant coarse fragments of pumice on the surface [9]. Furthermore, [25] generalized that the texture of the soils of the area ranges from sandy loam, loam to sandy clay loam with some clay loam and few clay soils.

The College has about 155ha allocated for cultivation of different types of crops such as fruits, vegetables, forages and multiplication of maize hybrid varieties (produced in collaboration with Ethiopian Seed Enterprise) for income generation purposes. Though the area coverage varies from year to year, onion is one of the most widely cultivated vegetable crops in the College. About 1,265ha of the College farmlands are regarded as potentially irrigable lands. Currently, furrow irrigation system is being practiced by diverting Jiddo River into three main dams constructed in the farmlands of different villages. Besides, the College has about 397ha of land under tree plantation. On the other hand, the College has livestock farms which are established along with the establishment of the campus and are currently intensively managed covering about half the budget of the

College together with crop production.

2.2. Experimental Procedure

The experiment was conducted on onion (with seeding rate of 3.5 kgs/ha) using a factorial experiment 4×4 treatment combinations laid down in a Randomized Complete Block Design (RCBD) with three replications. The treatments were a combination of four rates of N + P (0+40, 70+40, 80+40 and 90+40 kg N/ha and kg P/ha) and four levels of well decomposed poultry manure (0, 10, 20, 30t/ha) and consisted a total of 17 treatments including the control and the absolute control, where 0 kg N/ha, 0 kg P/ha and 0t/ha poultry manure. These treatments were randomly assigned to the experimental units within each block in accordance with the design. The sources of inorganic N and P were urea and Triple super phosphate (TSP), respectively.

The research was conducted under furrow irrigation following the prevailing cropping systems for dry season onion production. Different rates of poultry manure were prepared on the air dry-weight basis. Then, the respective rates were incorporated into the soil manually to each of the experimental unit before transplanting. Onion variety was nursed and transplanted to the field after 60 days of sowing. Other agronomic practices (weeding, cultivation, furrow irrigation, staking, etc.) were followed as recommended by the onion production.

Table 1. *Treatment combination.*

Treatments	$N+P_2O_5$ and Manure combination				
T_1 (absolute control)	0kgN	+	0kg P_2O_5	+	0t/ha manure
$T_{2\ (control)}$	0kgN	+	40kg P_2O_5	+	0t/ha manure
T_3	0kgN	+	40kg P_2O_5	+	10t/ha manure
T_4	0kgN	+	40kg P_2O_5	+	20t/ha manure
T_5	0kgN	+	40kg P_2O_5	+	30t/ha manure
T_6	70kgN	+	40kg P_2O_5	+	0t/ha manure
T_7	70kgN	+	40kg P_2O_5	+	10t/ha manure
T_8	70kgN	+	40kg P_2O_5	+	20t/ha manure
T_9	70kgN	+	40kg P_2O_5	+	30t/ha manure
T_{10}	80kgN	+	40kg P_2O_5	+	0t/ha manure
T_{11}	80kgN	+	40kg P_2O_5	+	10t/ha manure
T_{12}	80kgN	+	40kg P_2O_5	+	20t/ha manure
T_{13}	80kgN	+	40kg P_2O_5	+	30t/ha manure
T_{14}	90kgN	+	40kg P_2O_5	+	0t/ha manure
T_{15}	90kgN	+	40kg P_2O_5	+	10t/ha manure
T_{16}	90kgN	+	40kg P_2O_5	+	20t/ha manure
T_{17}	90kgN	+	40kg P_2O_5	+	30t/ha manure

The full rates of inorganic P source were applied as Triple supper phosphate TSP at the time of transplanting within the plant row as per the rate for each treatment as side dressing and mixed with the soil manually. The remaining N fertilizer rate was top dressed in the form of urea at early bulbing. The spacing between and within rows was 30×10cm, respectively. The gross area of each experimental unit was 1.8m×2m=3.6m^2 whereby each plot consists of six rows with a total of 20 plants per row. The space between blocks and plots are 1m and 1.5m, respectively.

2.3. Sampling and Sample Preparation

Poultry manure was collected from the poultry farm of Alage ATVET College and mixed thoroughly; two kgs of composite samples were prepared for laboratory analyses. Then the two kgs of composite samples were divided into two. The first half was taken for chemical analysis (concentration on of N, P, organic C, CEC, pH, and basic cations (K^+, Na^+, Mg^{++}, and Ca^{++}). The fresh and air dried weights were determined from the remaining part of composite manure sample. Finally, the moisture content was calculated from the fresh and air dry weights then used to determine the different rates of manure to be applied to each treatment on air dry weight basis. The manure used for the experiment had been for a period of one or more years and are well decomposed.

The soil Samples (0-30 cm deep) were collected randomly from each of the three blocks to obtain a total of three bulk samples. The soil samples were air dried and ground to pass through a 2mm sieve and analyzed for total N, available P, organic C, CEC, pH, and exchangeable basic cations (K^+, Na^+, Mg^{++}, Ca^{++}).

The chemical compositions of the soil and manure samples were analyzed Soil pH was measured potentiometrically using pH meter in the supernatant suspension of 1:2.5 soil to distilled water [16]. Organic C was determined following the wet digestion method as described by [37] whereas the modified Kjedahl procedure was followed for the determination of total N of soil and manure as described by [16]. Available phosphorus in soil and manure samples was extracted by Olsen extraction method [28]. The contents of P extracted by Olsen method was determined using spectrophotometer following the procedure described by [26]. Cation exchange capacity (CEC) of the soil was determined from the ammonium acetate saturated samples following the method described by [29].

Exchangeable bases (K^+, Na^+, Mg^{++}, Ca^{++}) in the soils and their total contents in the manure was extracted with 1M ammonium acetate (pH=7) solutions. The concentration of K^+, Na^+, Mg^{++}, and Ca^{++} in the extracts was measured using flame photometer. Percent base saturation (PBS) was estimated from the sum of exchangeable bases as a percent of the CEC of the soil. The texture of the soil sample was determined by hydrometric method [13].

2.4. Selected Chemical Composition of Manure and the Soil Before Transplanting

2.4.1. Soil Chemical Properties Before Transplanting

The pre-plant soil properties of the experimental field are shown in Table 2. The result indicates that the soil was alkaline (pH=8.12). The organic carbon and the total N were 1.426 % and 0.146 %, respectively, resulting in the C: N ratio of 9.76:1, similar to the generally established 10:1 C: N ratio for soil organic matter (Regassa, 2005). The extracted available phosphorus was 19.27ppm, suggesting the high concentration of available P in the study area. The available

K^+ (ppm) was 773.19 which indicate that the soil of the experimental field was very rich in available K^+. The CEC of the soils was 33.87 (Meq/100g), while the average percent base saturation was 99.02%. The result of CEC is generally low, while the percent base saturation is very high indicating that the soil of the experimental field is very low in exchangeable H^+ and Al^+. The exchangeable bases (Ca^{++}, Mg^{++}, K^+ and Na^+) were 23.69, 3.12, 6.10 and 0.77Meq/100g of soil, respectively. The result indicates that the soil was very rich in exchangeable Ca^{++} as compared to other cations followed by exchangeable K^+.

Generally, the contents of the soil fertility parameters studied are indicatives of the fact that soils of the study area are more or less deficient in most of the major plant nutrients particularly in N and Mg and are rich in both available and exchangeable K^+ and Ca^{++}. In addition, the alkalinity of soil reaction has a high tendency to limit crop production through decreasing the solubility of P due to high concentration of Ca^{++}. The percentage of sand, silt, and clay of the soil of the experimental field were 46.00, 39.33, and 14.67, respectively that is loam in its textural class (Table 3).

Table 2. *Selected chemical properties of the experimental field.*

Soil chemical properties	Mean	Standard deviation
pH (H_2O)	8.12	0.061
Organic carbon (%)	1.426	0.0490
Total Nitrogen (%)	0.146	0.008
Carbon to nitrogen ratio	9.82	0.869
Available P (ppm)	19.24	1.700
Available K (ppm)	773.19	47.545
Exchangeable Ca (Meq/100g)	23.69	0.329
Exchangeable Mg (Meq/100g)	3.12	0.351
Exchangeable K (Meq/100g)	6.10	0.278
Exchangeable Na (Meq/100g)	0.77	0.078
Cation exchange capacity (Meq/100g)	33.87	0.503
Percent base saturation (%)	99.02	0.944

Table 3. *Texture of the soil of experimental field.*

Soil particle	Mean (%)	Standard deviation
Sand	46	2.00
Silt	39.33	1.15
Clay	14.67	3.06

2.4.2. Chemical Composition of Poultry Manure

The data on the chemical composition of manure in this study are presented in Tables 4 & 5. The result of the analysis revealed that manure contained considerable amounts of plant nutrients. Accordingly, the organic carbon and total nitrogen contents of manure were 40.60% and 2.60%, respectively with a resultant narrow C: N ratio of about 15.61. The narrow carbon to nitrogen ratio in the organic nutrient source indicates that the manure is well decomposed.

The concentration of available phosphorus in manure was 0.9%. Similarly, the average concentration of basic cations, namely Ca^{++}, Mg^{++} and K^+ were 3.49%, 2.92% and 1.44% respectively, while the CEC was 46.68Meq/100g of manure (Table 4).

Based on the laboratory analysis, the total quantity of nitrogen applied to the soil from the application of manure at the rates of 10, 20 and 30t/ha were 260, 520 and 780kgN/ha, respectively (Table 5). These amounts of applied N are equivalent to 565.22, 1130.44 and 1695.66kg urea (46%N) per hectare, respectively. Similarly, the available P applied to the soil from the application of manure at the rates of 10, 20 and 30t/ha was 90kg, 180kg and 270kg, respectively. These amounts of applied available P are equivalent to 195, 390 and 585kg of TSP (46 % P), respectively. The available K^+ applied to the soil from the application of manure at the rates of 10, 20 and 30t/ha were also 144, 288 and 432kg/ha which are also equivalent to 292, 584 and 876 kg muriate of potash (49.78% K^+), respectively. The average amount of organic carbon applied to the soil in association with the application of poultry manure ranged from 4,060kg/ha, from the rate of 10t/ha to 12180kg/ha from the rate of 30t/ha.

Similarly, the total quantities of basic cations (Ca^{++}, Mg^{++}, and K^+) applied were 349, 698 and 1047kg/ha from the application rates of 10, 20 and 30t/ha of manure, respectively. In addition, the manure had probably supplied the soil with appreciable amounts of micronutrients such as Mn^{++}, Fe^{++}, Zn^{++} and others [36]. This implies that manure is a source of most micronutrients and, this is capable of sustaining vegetable crops production.

Table 4. *Elemental composition and Total nutrient content of poultry manure.*

OC (%)	Total N (%)	C:N ratio	Avail P_2O_5	Exchangeable basic cations (%)			CEC (meq/100g)
				Ca	Mg	K	
40.6%	2.60%	15.61	0.9%	3,49%	2.92%	1.44%	46.68

OC=organic carbon, C:N carbon to nitrogen ratio, CEC=cation exchange capacity

Table 5. *Average quantity of nutrients (kg) supplied to the different rate of poultry manure per hectare.*

Manure (t/ha)	OC (Kg/ha)	Total N (Kg/ha)	Avail. P (Kg/ha)	Exchangeable bases Kg/ha			Basic cations
				Ca	Mg	K	
10	4060	260	90	349	292	144	785
20	8120	520	180	698	584	288	1570
30	12180	780	270	1047	876	432	2355

2.4.3. Agronomic Data Collection

10 plants were randomly taken from each experimental units and arranged into yield (bulb) and vegetative parts to measure the plant height, leaf length, leaf number, leaf biomass, dry biomass, root biomass, total bulb yield, mean bulb weight, bulb diameter, Dry Bulb Weight and harvesting

index.

2.4.4. Statistical Analysis

Data on the plant growth and yield were subjected to analysis of variance using Statistical Analysis System Institute Package (SAS) and the mean values were compared using the Duncan's multiple rang taste (DMRT) at P<0.01 [15].

3. Results and Discussion

3.1. Vegetative Growth

3.1.1. Plant Height

The analysis of variance showed that there was a significant difference (p<0.01) in the interaction of the organic and inorganic fertilizers The highest plant height (61.42cm) was recorded at the plots receiving 90kg N/ha, 20t/ha poultry manure and 40kg P/ha in combined application and the least plant height was obtained at combined application of 0kg N/ha, 0t/ha poultry manure and 0kg P/ha which was the absolute control. The highest plant height was statistically similar with T_4, T_5, T_7, T_8, T_9, T_{11}, T_{12}, T_{13}, T_{14}, T_{15}, T_{16} and $T_{17.}$ There was no significant difference between the control (0, 0, and 40) and the absolute control (0, 0, 0). The difference in plant height observed in response to combined application of nitrogen fertilizer and poultry manure may be due to the roles of organic and inorganic fertilizers on plant growth and development that means nitrogen is responsible in cell division and elongation which leads to rapid growth and development of root, stem and leaves. On the other hand Poultry manure application improved the soil moisture content this improvement in soil moisture content might be due to the colloidal and hydrophobic nature of the poultry manure. Organic matter is known to improve soil physical properties [1, 4]. Addition of poultry manure to the plots reduced the soil bulk density; this reduction in soil bulk density could make appreciable difference in the root growth and development. This separate role of organic manure may support the effect of inorganic fertilizer to show its maximum effect. This result is supported by [11] that nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield when both fertilizers were combined [27] observed that nutrient use efficiency might be increased through the combination of manure and mineral fertilizer [35] found that organic waste/fertilizer alone could hardly be depended upon as the sole source of nutrient for a short duration crop like maize. On the average, the combined application of NPK fertilizer and poultry manure appeared satisfactory for obtaining high grain yield of maize, seed yield of melon and fresh tuber yield of cassava.

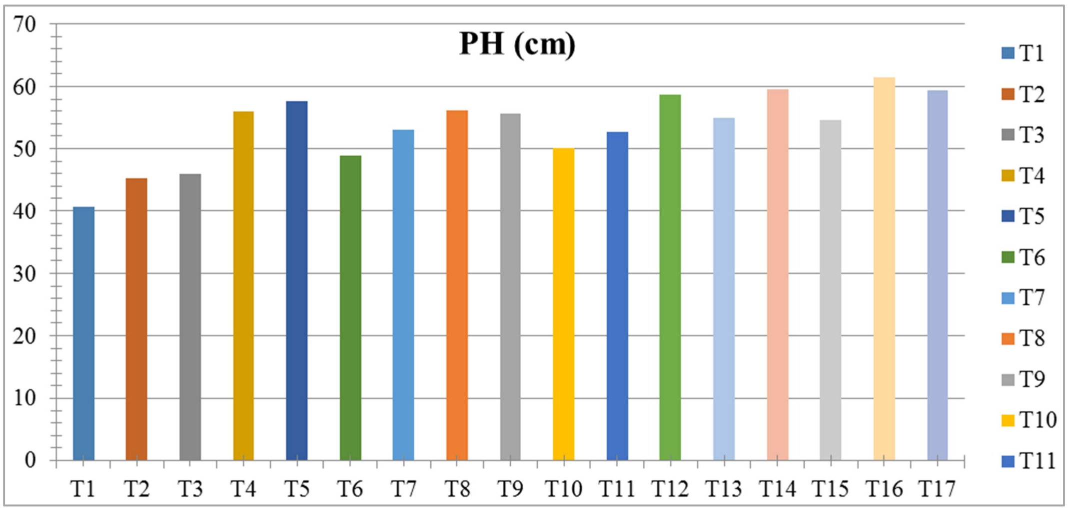

Figure 1. *Treatment effect on plant height.*

3.1.2. Leaf Number

The interaction of organic and inorganic fertilizers caused significant differences (p<0.01) on the leaf number of the onion. The highest leaf number (16) was recorded at the combination of 90kg N/ha, 30t/ha poultry manure and 40kg P/ha which was significantly higher than the all treatments. The least leaf number was recorded at the absolute control (3) plot receiving (0, 0, 0). T_{12} also recorded (15) more numbers of leaves next to the T_{17}. This result may be observed due to the combined effect of poultry manure and inorganic fertilizers. Because, their combined effect may enhance good soil condition, fast and healthy growth for the leaves of onion. Obviously nitrogen is known in in its effect on the vegetative parts of the crops. That it accelerates cell division and elongation which indirectly improve the growth and development of the crop. The result is in line with that of [14] obtained similar results, where the application of NP fertilizer at ½ the recommended rate combined with farmyard manure (FYM) either at the full or ½ the recommended rate were as effective as the full NP rate for plant growth.

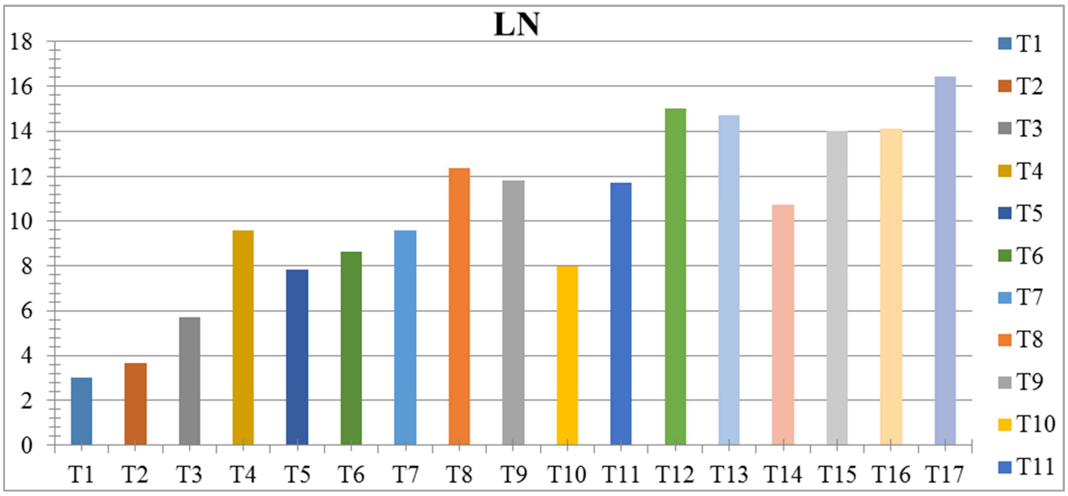

Figure 2. *Treatment effect on Leaf number.*

3.1.3. Leaf Length

Leaf length was also affected by the interaction of organic and inorganic fertilizers at the probability level of p<0.01. Complementary application produced highest leaf length (49.82cm) at T_9 (60kg N/ha, 30t/ha poultry manure and 40kg P/ha), but this had no significant difference with T_{12} (47.97cm), T_{14} (47.17cm), T_{16} (43.76cm), T~~$_{12}$~~ (42.99cm), T_5 (42.59cm), T_{13} (42.00cm), T_7 (41.74cm) and T_8 (41.47cm). However it was significantly different from the control, absolute control and the remaining treatments. The least length (28.11cm) was recorded at the control plot which was statistically the same with the absolute control. This result may be due to the interaction effect of inorganic fertilizers and organic fertilizers on the growth and development of plants and the soil properties. That is the physiological importance of nitrogen may be supported by the role of organic fertilizer on the soil amendment [1, 4]. Application of organic fertilizers improves the water retention capacity of the soil, easy root penetration. According to [18] enhancement of soil water retention capacity due to animal manure could probably be due to structural improvement i.e. increase in total porosity and the fraction of porosity involved in soil water storage.

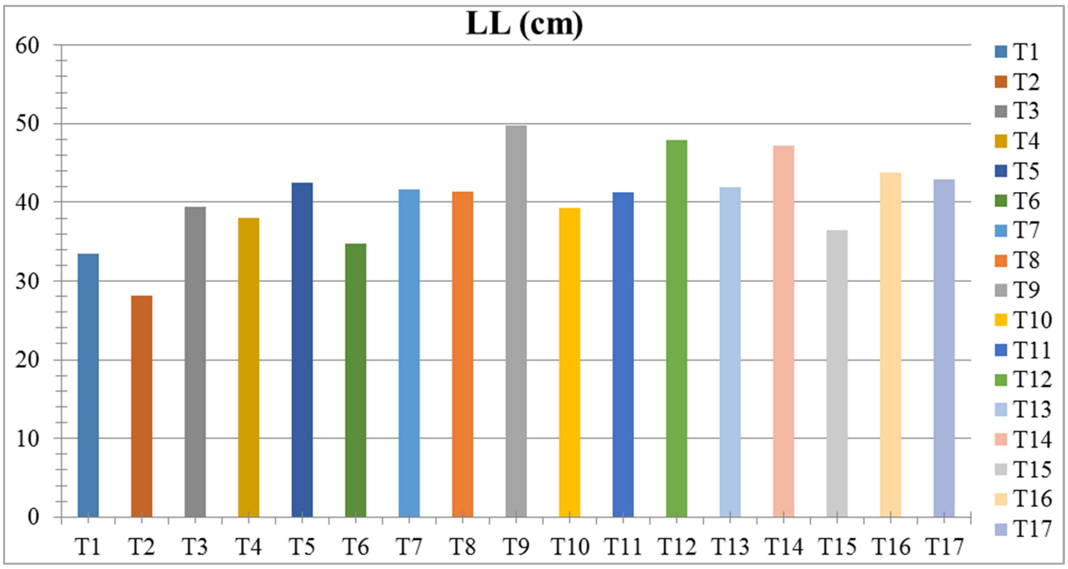

Figure 3. *Treatment effect on Leaf length.*

3.1.4. Leaf Weight

The interaction of inorganic and organic fertilizer had a significant effect on the leaf weight at the probability level of p<0.01. The highest leaf weight (10.32g) was recorded by the combined application of organic and inorganic fertilizers at T_{16} (120kg N/ha, 20t/ha poultry manure and 40kg P/ha) and followed by (10.19g) plot receiving T_{17} (120kg N/ha, 30t/ha poultry manure and 40kg P/ha) and (9.53g) T_{13} (80kg N/ha, 30t/ha poultry manure and 40kg P/ha) with no significant difference. However these all were significantly different from the control (6.68g) and absolute control (6.75g) where statistically difference was not observed. This observation may be due to the combined effect of poultry manure and inorganic fertilizers on the areal part of the plant. Like the organic fertilizers plays important role in improving the chemical properties of the soil which supplement the inorganic fertilizers' share. Generally soil chemical properties could be changed due to the application of organic fertilizers which have significant role on the availability of inorganic fertilizer. This is in agreement with [18] that adsorption of B by Fe and Al hydroxides also occurs but it is much pH dependent- maximum adsorption at pH 7 for $Al(OH)_3$. Micronutrients might be released from poultry manure that had significant role on the vegetative growth of onion which is in partial concurrence with the findings of [33, 12] studied that the plant height and fresh weight of leaves were positively affected by micronutrients.

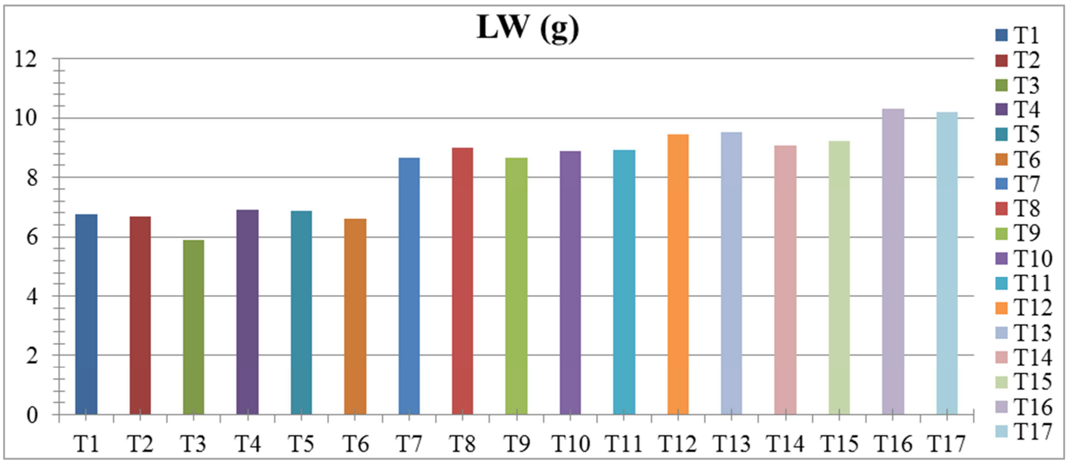

Figure 4. *Treatment effect on leaf weight.*

3.1.5. Root Weight

Interaction was also affect the weight of root at the probability of the p<0.01. The highest root weight (1.40g) was recorded at the combination of the T_{12} (80kg N/ha, 20t/ha poultry manure and 40kg P/ha) which had statistical similarity with T_{16} (120kg N/ha, 20t/ha poultry manure and 40kg P/ha) (1.34g) and T_{16} (120kg N/ha, 30t/ha poultry manure and 40kg P/ha) (1.26g). The increase in amount of nitrogen and poultry manure had direct relation with the growth of root and root weight. This result may be due to the cumulative effect of organic and inorganic fertilizers on the soil physical and chemical properties and nutrient availability. Proper root growth may be enhanced by the soil physical, chemical and biological nature that could be improved by the application of organic fertilizer [1]. The result is in line with that of [14] obtained similar results, where the application of NP fertilizer at ½ the recommended rate combined with farm yard manure (FYM) either at the full or ½ the recommended rate were as effective as the full NP rate for plant growth.

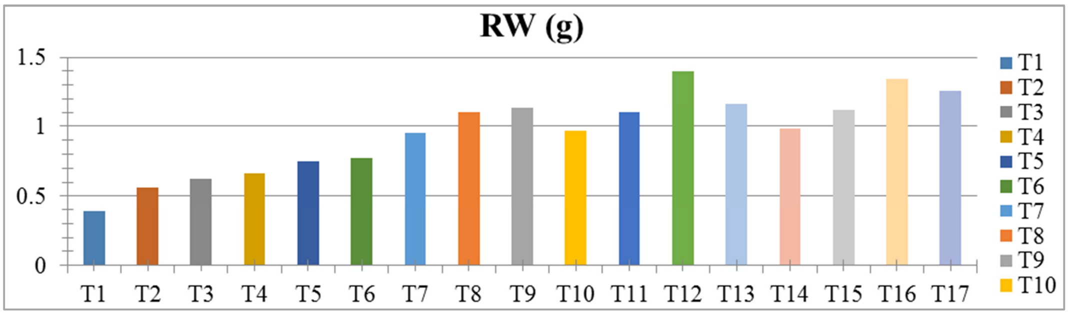

Figure 5. *Treatment effect on Root weight.*

3.2. Bulb Characteristics

3.2.1. Mean Bulb Weight

The interaction was also affect the mean bulb weight at the probability of the p<0.01. The highest mean bulb weight (61.71g) was recorded at the treatment of T12 (80kg N/ha, 20t/ha poultry manure and 40kg P/ha) which had significant difference from all other treatments including control and absolute control. The control treatment had no significant difference from the absolute control. The result revealed that as the amount of nitrogen increased to the 120kg/ha, and at any rate of poultry manure mean bulb weight seamed to decrease. This may be excessive supply of nitrogen in combination with organic fertilizers enhances fast growth and development of vegetative parts up to some maximum. Above this maximum the uptake of plant might decrease.

This result was in line with [5] that reported further increase in nitrogen fertilizer (160 kg/ha) tended to depress bulb yield.

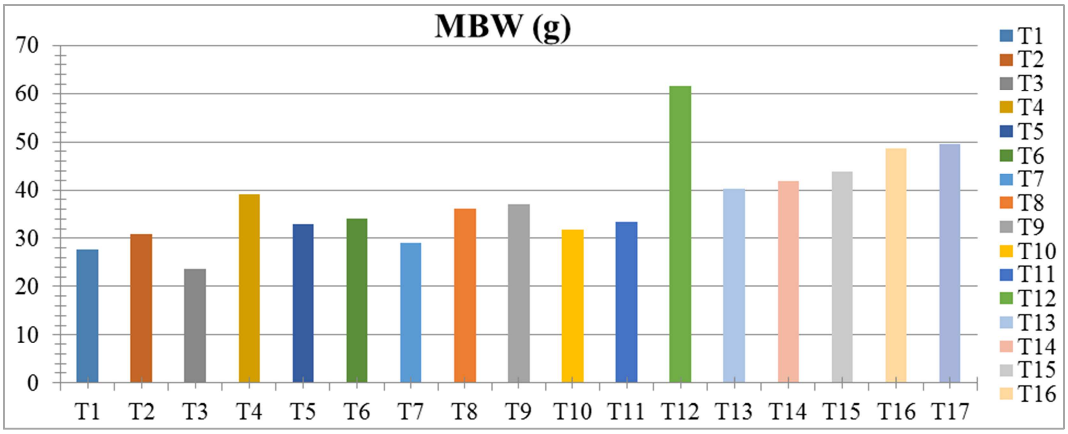

Figure 6. *Treatment effect on Mean bulb weight.*

3.2.2. Bulb Diameter

Analysis of variance showed that there was a significant effect due to the interaction of organic and inorganic. The highest bulb diameter was recorded at the plot received treatment T_{16} Where 120kgN/ha and 20t/ha of poultry manure. But it was not significantly different from T_{17}, T_{15}, T_{14} and T_{13}. This highest result was also significantly different from the control and the absolute control. This result may be recorded due to the application of more inorganic and organic fertilizers. Applying more organic and inorganic fertilizers may bring significant change on the yield parameters because both their Owen rolet The result corroborates the findings of [3, 24] who indicated that the addition of town refuse at rates of 4.8 and 9.5 t/ha nitrogen fertilizer up to 150kg/ha increased the bulb diameter significantly.

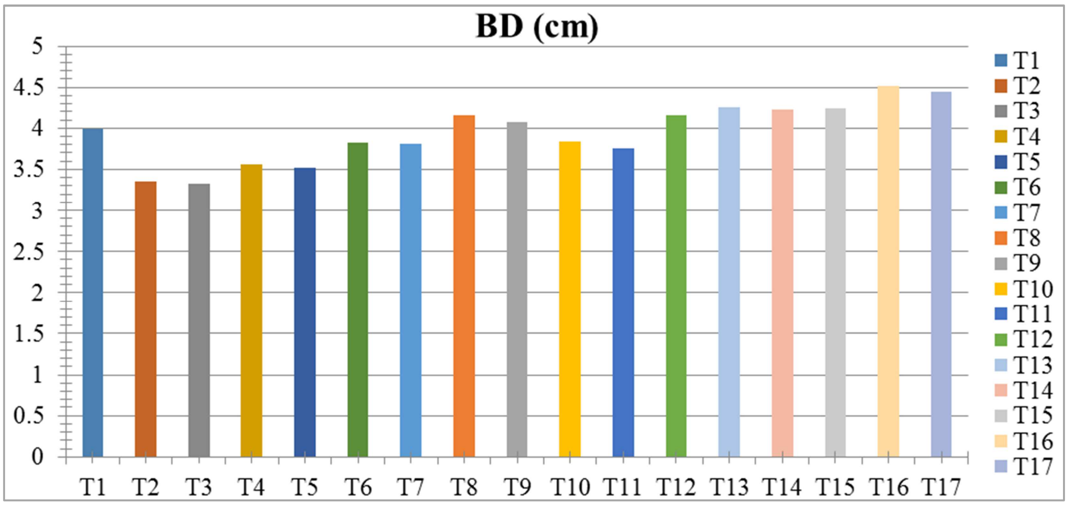

Figure 7. *Treatment effect on Bulb diameter.*

3.2.3. Bulb Dry Weight

The bulb dry weight was found to be significant ($p<0.01$) due to the interactive effect of different rates of inorganic and organic fertilizers. The highest bulb dry weight was obtained at T_{11} (80kg/ha, 10t/ha PM and 40 kg P/ha) this was statistically similar with T_{17}, T_{13}, T_{12}, T_9, T_8, and T_4. The control treatment T_2 was significantly higher than the absolute control that showed the effect of phosphorous on the dry bulb weight was significantly higher. This improvement in dry weight could be explained through the role of phosphorus with nitrogen and poultry manure which is extremely important as a structural part of many components, notably nucleic acid, and phospholipids. The result of this study is in line with the finding of [32] who in their study on the effect of different rates of phosphorus fertilizer, observed increments in dry weight of whole plant with increasing the rates up to 49 kg of P per ha. [11] also reported that nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield when both fertilizers were combined.

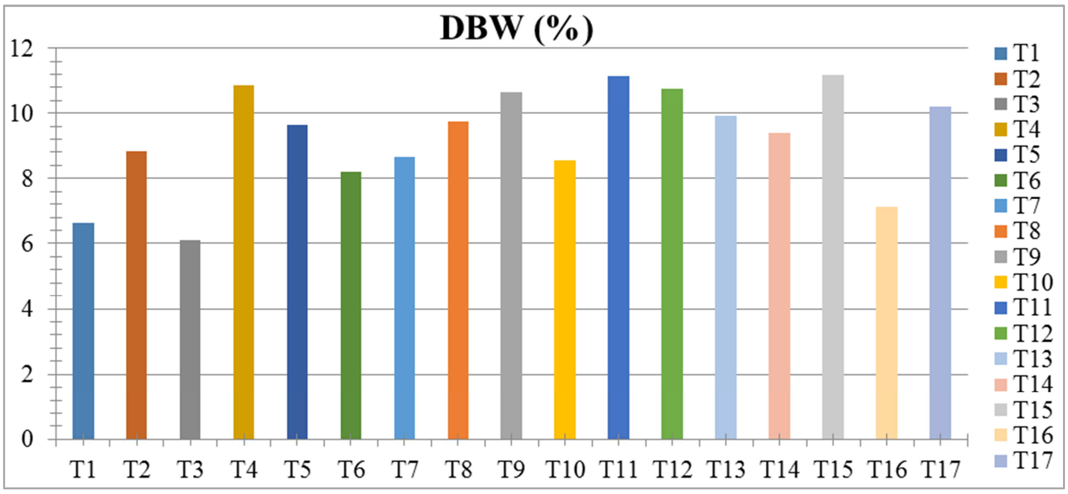

Figure 8. *Treatment effect on Dry bulb weight.*

3.2.4. Total Bulb Yield

The interaction effect of inorganic and organic fertilizers was significant at the probability level of $p<0.01$. The highest total bulb yield (20.57t/ha) was obtained with the complementary application of 20 t/ha poultry manure, 80 kg N/ha nitrogen and 40 kg P/ha fertilizers at T_{12}. As the nitrogen amount increase at any rate of poultry manure the total bulb weight was tended to decrease. This result may be due to reduction of uptake of nutrients as amount of nutrient increases beyond the demand of the crop. This is in harmony with [5] that further increase in nitrogen fertilizer (160 kg/ha) tended to depress bulb yield. Also the findings of [21] reported that in long term fertility studies in Northern Nigeria it was shown that 5 t/ha of animal dung annually combined with 100 kg N and 21.5 kg P maintained yield under continuous cropping of onion. Also [34] reported that application of one season 2 t/ha FYM and inorganic fertilizer (61 kg N/ha, 31 kg P/ha) gave the highest bulb yield of shallot. Also the findings of [35] who reported that the most that the most satisfactory method of increasing maize yields was by judicious combination of organic wastes and inorganic fertilizers. [2] advocated for better farming systems which employ a combination of fertility building practices appropriate to local conditions for crop production in south west Nigeria. [11] also reported that nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield when both fertilizers were combined. [27] observed that nutrient use efficiency might be increased through the combination of manure and mineral fertilizer. [35] found that organic waste / fertilizer alone could hardly be depended upon as the sole source of nutrient for a short duration crop like maize.

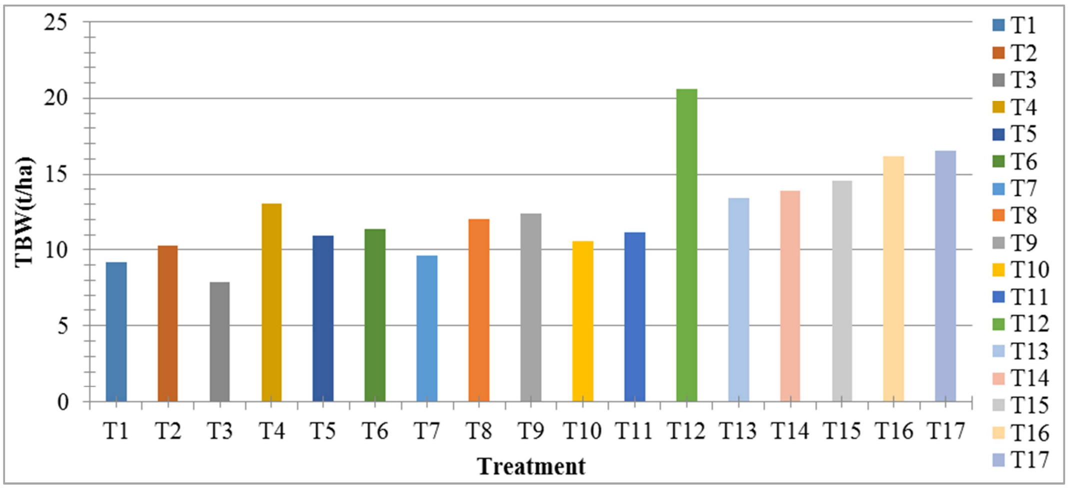

Figure 9. *Treatment effect on Total bulb weight.*

3.2.5. Harvest Index

The significant differences were observed on harvest index of onion as a result of the interaction effects of poultry manure, inorganic nitrogen application. This result may be due to the important role of inorganic and organic fertilizers for the growth of parts of the onion. The above result agrees with the findings of [38] who reported that the highest harvest index in Adama Red cultivar was recorded from treatments that received N and FYM at 25 kg N + 8 t

FYM/ha.

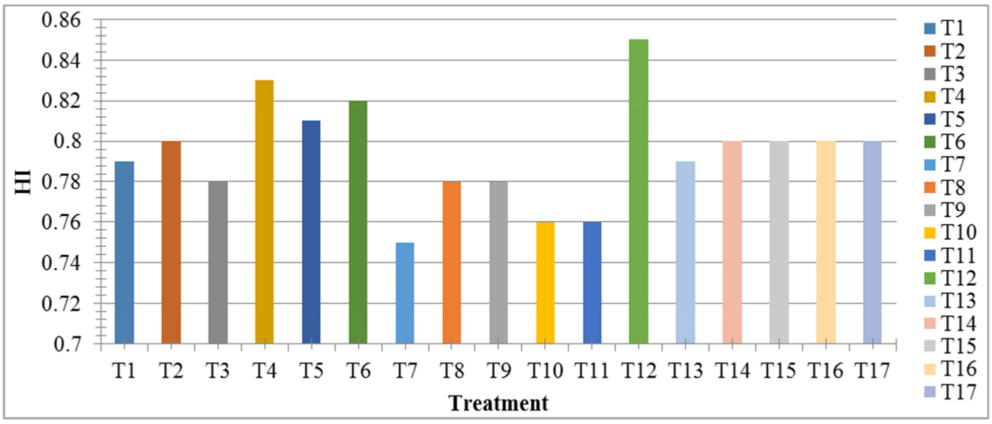

Figure 10. *Treatment effect on Harvesting index.*

Table 6. *Interaction effects of N, PM, and P2O5 on PH, LN, LL, LW and RW, BD, MBW, HI, DBW TBW.*

Treatment	PH (cm)	LN	LL (cm)	LW (g)	RW (g)	BD (cm)	TBW (t/ha)	MBW (g)	HI	DBW (%)
T1=(0,0,0)	40.56^{f}	3.04^{i}	33.41^{fg}	6.75^{e}	0.39^{g}	3.99^{cde}	9.23$_{jk}$	27.70^{kl}	0.79^{cdef}	6.64^{f}
T2=(0,0,40)	45.19^{ef}	3.68^{i}	28.11^{e}	6.68^{ef}	0.56^{fg}	3.35^{g}	10.28^{ij}	30.84^{ijk}	0.80^{bcde}	8.83^{cde}
T3=(0,10,40)	46.02^{def}	5.72^{h}	39.47^{cdef}	5.89^{f}	0.62^{ef}	3.32^{g}	7.8933^{k}	23.68^{l}	0.78^{defg}	6.09^{f}
T4=(0,20,40)	55.96^{abc}	9.60^{ef}	38.06^{def}	6.90^{e}	0.66^{ef}	3.56^{fg}	13.03^{def}	39.09^{defg}	0.83^{ab}	10.88^{ab}
T5=(0,30,40)	57.63^{abc}	7.85^{g}	42.59^{a-e}	6.86e	0.75^{e}	3.52^{fg}	10.95^{ghi}	32.87^{hijk}	0.81^{bcde}	9.63^{bcde}
T6=(60,0,40)	48.96^{cdef}	8.63^{fg}	34.77^{efg}	6.62^{ef}	0.77^{e}	3.82^{def}	11.34^{ghi}	34.03^{ghij}	0.82^{abc}	8.20^{e}
T7=(60,10,40)	53.08^{a-e}	9.57^{ef}	41.74^{a-f}	8.67^{d}	0.95^{cd}	3.81^{def}	9.66^{ij}	28.99^{jkl}	0.75^{h}	8.66^{de}
T8=(60,20,40)	56.05^{abc}	12.37^{c}	41.47^{a-f}	8.98^{dc}	1.10^{bcd}	4.15^{bcd}	12.05^{fgh}	36.16^{fghi}	0.78^{def}	9.75^{abcd}
T9=(60,30,40)	55.60^{abc}	11.82^{cd}	49.82^{a}	8.82^{dc}	1.13^{bc}	4.07^{cde}	12.36^{efg}	37.08^{efg}	0.78^{defg}	10.64^{ab}
T10=(80,0,40)	50.08^{bcde}	8.00^{g}	39.22^{cdef}	8.89^{cd}	0.97^{cd}	3.84^{def}	10.58^{hij}	31.75^{hijk}	0.76^{gh}	8.57^{de}
T11=(80,10,40)	52.73^{a-e}	11.73^{cd}	41.23^{b-f}	8.93^{dc}	1.10^{bcd}	3.75^{ef}	11.15^{ghi}	33.47^{hij}	0.76^{fgh}	11.14^{a}
T12=(80,20,40)	58.69^{ab}	15.00^{b}	47.97^{ab}	9.45^{bcd}	1.40^{a}	4.16^{bcd}	20.57^{a}	61.71^{a}	0.85^{a}	10.76^{ab}
T13=(80,30,40)	54.99^{abc}	14.72^{b}	42.00^{a-e}	9.53^{abc}	1.16^{b}	4.25^{abc}	13.42^{def}	40.28^{def}	0.79^{c-g}	9.92^{abcd}
T14=(120,0,40)	59.56^{a}	10.74^{de}	47.17^{abc}	9.07^{dc}	0.98^{cd}	4.23^{abc}	13.91^{de}	41.75^{de}	0.806^{cde}	8.71^{de}
T15=(120,10,40)	54.58^{abcd}	14.02^{b}	36.41^{defg}	9.22^{dc}	1.12^{bcd}	4.24^{abc}	14.59^{cd}	43.78^{cd}	0.80^{bcde}	9.51^{bcde}
T16=(120,20,40)	61.42^{a}	14.12^{b}	43.76^{abcd}	10.32^{a}	1.34^{a}	4.52^{a}	16.20^{bc}	48.61^{bc}	0.80^{bcde}	9.78^{abcd}
T17=(120,30,40)	59.35^{a}	16.46^{a}	42.99^{a-e}	10.19^{ab}	1.26^{ab}	4.44^{ab}	16.56^{b}	49.68^{b}	0.819^{bcd}	10.21^{abc}
CV %	7.01	6.07	9.27	4.24	8.61	3.60	6.27	6.66	1.75	8.67
LSD	8.91	1.38	8.41	0.8	0.16	0.31	1.68	5.42	0.03	1.45

Means followed by the same letter within a column are not significantly different at the probability level indicated (p< 0.01 = **) using least significant difference.

3.3. The Relation Between Yield and Yield Components

Correlation coefficient values (r) computed to display the relationships between and within agronomic parameter of bulb yield onion crop are shown in Table 7. The correlation values showed apparent association of the parameters of the crop with each other. The result of correlation analysis on total bulb yield and growth characteristics indicated that, there was a positive correlation between total bulb yield, leaf number, plant height, bulb diameter, bulb dry weight, and mean bulb weight (Table 7). The correlation between total bulb yield and the above mentioned parameters was significant (p<0.01). These indicate that the application of fertilizer had influenced total bulb yield, bulb yield parameters and plant growth positively. This generally implies that, as the number of leaves increased total bulb yield also increased. The same is true for other yield related parameters with total bulb yield relationship.

Table 7. *Pearson correlation coefficient within and between yield and yield related components.*

	PH	LN	LL	LW	RW	BD	MBW	HI	DBW
LN	0.65134								
P value	<.0001								
LL	0.44306	0.54737							
	0.0011	<.0001							
LW	0.57869	0.8197	0.49359						
	<.0001	<.0001	0.0002						
RW	0.64101	0.91033	0.59518	0.86664					
	<.0001	<.0001	<.0001	<.0001					

	PH	LN	LL	LW	RW	BD	MBW	HI	DBW
BD	0.43073	0.72438	0.49175	0.78725	0.7008				
	0.0016	<.0001	0.0002	<.0001	<.0001				
MBW	0.58928	0.7588	0.38906	0.64844	0.71829	0.71829			
	<.0001	<.0001	0.0048	<.0001	<.0001	<.0001			
HI	0.20112	0.16913	-0.03667	0.14275	0.02326	0.02326	0.02326		
	0.157	0.2354	0.7983	0.3177	0.8713	0.8713	0.8713		
DBW	0.39297	0.50217	0.26941	0.34842	0.41629	0.41629	0.41629	0.22338	
	0.0043	0.0002	0.0559	0.0122	0.0024	0.0024	0.0024	0.1151	
TBW	0.58928	0.7588	0.38906	0.64844	0.71829	0.71829	0.71829	0.6363	0.42675
	<.0001	<.0001	0.0048	<.0001	<.0001	<.0001	<.0001	<.0001	0.0018

PH=plant height, LN=Leaf number, LL=Leaf length, LW=leaf weight per plant, RW=Root weight per plant, BD= bulb diameter, MBW=Mean bulb weight, HI=Harvesting index, DBW=Dry bulb weight TBW=Total Bulb weight

4. Summary and Conclusion

4.1. Summary

The interaction effects of poultry manure and inorganic fertilizers significantly affect most of the yield and yield parameters. A combination of 20t/ha poultry manure and inorganic fertilizers at the rate of 80kg/ha N with 40kg/ha P_2O_5 resulted in the highest total bulb yield, and most yield components of onion.

In this study, the application of poultry manure significantly improved the yield and yield components of onion. In its main effect significant differences were observed in plant height, leaf number, leaf length, leaf weight, root weight, total bulb weight, mean bulb weight, harvesting index, and dry bulb weight of onion. Poultry manure at 20t/ha resulted in the highest yield and most yield related components which had positive correlations with the yield.

Application of inorganic fertilizers also significantly influenced the yield and most of yield related components of onion. The result showed that, there was a significant difference ($P<0.01$) in the plant height, leaf number, leaf length, leaf weight, root weight, total bulb weight, mean bulb weight, harvesting index, and dry bulb weight of onion. Based on our findings, the main effect of inorganic fertilizers applied at the rate of 120kgN/ha and 40kg/ha P_2O_5 resulted in the highest yield and most yield related parameters.

4.2. Conclusion

From this study result, I can conclude that using manure specially poultry manure for agriculture in combination with inorganic fertilizer at the rate of 80kg N/ha and 20t/ha poultry manure to get the advantage of yield increment and amending the soil's physical and chemical properties as well as the cost for purchasing inorganic fertilizer believes to be reduced relative to the solo application of inorganic fertilizer. Doing this means having double or more benefits from fertilization activity of the agriculture because; soil has remarkable effect on crop productivity. Generally the effect of poultry manure and inorganic fertilizer depends on environmental conditions, type of the crop and also the specific season. Therefore, there is a need to undertake similar studies using poultry manure on onion and other vegetable crops with the following areas of emphasis.

1) On the effects of a mixture of poultry manure and inorganic fertilizers on the yield and yield components of onion and other vegetable crops in different agro ecological zones.
2) Effects of poultry manure in combination with inorganic fertilizer on the quality of onion and other vegetable crops.
3) This one season study has to be conducted across seasons and different locations of similar agro-ecology, soil type and crop management in order to draw firm conclusions and make final recommendation.

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Conflicts of Interest

The authors declare no conflicts of interest.

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