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Effects of Nitrogen and Phosphorus Rates on Growth, Yield, and Quality of Onion (*Allium cepa* L.) At Menschen Für Menschen Demonstration Site, Harar, Ethiopia

Birhanu Messele*

Department of Plant Sciences, Agro-Technical and Technology College, Ethiopia

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***Corresponding author:** Birhanu Messele, Department of Plant Sciences, Menschen fur Menschen Foundation, Agro-Technical and Technology College, Harar, P.O. Box: 322, Ethiopia, Tel: +251911393713; Fax: 025-66-37-37; Email: birhanmartha@gmail.com

Abstract

A field experiment was conducted during the 2015 growing season from March to July to determine the N and P rates for optimum yield, growth and quality of onion (*Allium cepa* L.), a factorial combination of two rates of N (0&50kg ha^{-1}) and two rates of P (0&75 kg ha$^{-1)}$ were used for the experiment. Treatments were laid down in a Randomized Complete Block Design (RCBD) in a factorial combination with three replications. The result of this study revealed that the application of nitrogen showed significant effects in most of studied characters while P fertilization and the interaction effect N and P did not. Application of 50 kg N ha^{-1} increased plant height and leaf length by about 10.46 and 5.82%, respectively, over the check. Number of leaves increased by about 8.59% in response to the application of 50 kg N ha^{-1} over the control. Leaf diameter and bulb length were not influenced by N fertilization. Phosphorus fertilization and its interaction with N did not significantly affect onion plant height, leaves number and length. Application of 75kg ha^{-1} increased bulb length by about 22.28%, respectively, over the control. Application of 50 kg N ha^{-1} increased the average bulb weight by 46.2%. The results of this experiment indicated that the application of 50kgN per ha increased the total and marketable bulb yield about 46.2 and 60.4 % respectively over the control (1.43and 0.001t/ha respectively).

Keywords: *Allium cepa*; Nitrogen; Phosphorus

Abbreviations: MCSO: (+)-S-methyl-L-Cysteine Sulphoxide; ADP:Adenosine di Phosphate; ATP: Adenosine Triple Phosphate; ACSOs: Alk (en)yl Cysteine Sulphoxide; BoA: Bureau of Agriculture; CEC: Cation Exchange Capacity; CSA: Central Statistical Authority; CV: Coefficient of Variation; DTM: Days to Physiological Maturity; DAP: Diammonium Phosphate; DNPH: Dinitrophenylhydrazine; DM: Dry Matter; Wf: Final Weight; FAO: Food and Agriculture Organization of the United Nations; GA: Gibberellic Acid; ha: Hectare; Wi: Initial Weight; ICRISAT: International Center for Research in the Semi-Arid Tropics; Masl:Meter above sea level; MoARD: Ministry of Agriculture and Rural Development; OC: Organic Carbon; OM: Organic Matter; SEM: Standard Error of the Mean; SEM: Standard Error of the Mean; TN: Total Nitrogen; TSS: Total Soluble Solid; PECO: trans – (+) s- (1-propenyl) – cysteine sulphoxide; TCA: Trichloroacetic Acid; WL: Weight Loss; RCBD: Randomized Complete Block Design

Introduction

The onion *(Allium cepa L.)* belongs to the family alliaceae and is one of the oldest cultivated vegetable, for over 4000 years. It is probably originated in central Asia between Turkmenistan and Afghanistan where some of its relatives still grow as wild plants [1]. From central Asia, the supposed onion ancestor had probably migrated to the Near East. Then it was introduced to India and South-East Asia; and into the Mediterranean area and from there to all the Roman Empire [2].

Allium cepa is a popular vegetable everywhere and its bulb is used raw, sliced for seasoning salads, and cooked with other vegetables and meat. The onion bulbs are essential ingredients in many African sauces and relishes. If consumed in small amounts for their pungency, they can be considered as condiments. The leaves, whole immature plants (called 'salad onion' or spring onion'), or leafy sprouts from germinating bulbs are used in the same way. In some parts of West Africa, leaves still green at bulb harvest are propounded, and then used to make sun-dried and fermented balls, which are used later for seasoning dishes

[2]. The extracted distillate from *Allium cepa L.*, commonly referred as "Onion oil" is extensively used in the food industry as seasoning and flavoring agent for savory products. Onion is considerably important in the daily Ethiopian diet. All the plant parts are edible, the bulbs and the lower section of stem are the most popular as a seasoning or a vegetable in stews.

Onions are rich in two chemical groups that have perceived benefits to human health. These are flavonoids and alk(en)yl cysteine sulphoxide (ACSOs). Two flavonoids sub groups are found in onion, the anthocyanins, which impart a red or purple color to some varieties and flavones such as quercetin and its derivatives responsible for the yellow and brown skins of many other varieties. The ACSOs are the flavour precursors, which, when cleaved by the enzyme alliinase, generate the characteristic odour and taste of onion. The downstream products are a complex mixture of compounds which include thiosulfates, thiosulfonates, mono-, di- and tri-sulfides [2].

Although onion is usually thought of as a vegetable, it also has a long history of medicinal use. Evidences suggest that onions may be effective against the common cold, heart disease, diabetes, osteoporosis, and other diseases. Compounds from onion have been reported to have a range of health benefits which include anti-carcinogenic properties, antiplatelet activity, antithrombotic activity, asthmatic and antibiotic effects [3]. In many parts of the underdeveloped world, onions are used to heal blisters and boils. In homeopathic medicine, *Allium cepa* is used for rhinorrhea and hay fever.

Onions are the second most valuable vegetable in the world, following tomato. In 2005, China was the largest producer of onions (including shallots) and China accounted for at least one-third of the global output followed by India, USA and Turkey [4]. *Allium cepa* as bulb onion and/or shallot is probably cultivated in all countries of tropical Africa. Important production areas for bulb onion are Senegal, Mali, Burkina Faso, Ghana, Niger, Nigeria, Chad, Sudan, Ethiopia, Kenya, Tanzania, Uganda, Zambia and Zimbabwe [2]. Onion is one of the economically important olericultural products in Ethiopia. During 2006 'Meher season', 16578.7 hectare (ha) of onions were planted, yielding a total production estimate of greater than 1.7 million quintals with an average yield of 106.11 quintals per ha [5].

1Onions are most susceptible than most crop plants in extracting nutrients, especially the immobile types, because of their shallow and unbranched root system; hence they require and often respond well to addition of fertilizers. Nitrogen (N) and phosphorus (P) are often referred to as the primary macronutrients because of the probability of plants being deficient in these nutrients and because of the large quantities taken up from the soil relative to other essential nutrients [6].

Nitrogen is required in much greater quantities than most of the nutrients. Nitrogen is an important component of proteins, enzymes, and vitamins in plants, and is a central part of the essential photosynthetic molecule, chlorophyll [6]. Plant demand for N can be satisfied from a combination of soil and fertilizer N to ensure optimum growth.

Phosphorus deficiency is one of the largest constraints to crop production in many tropical soils, owing to low native content and high P fixation capacity of the soil [7]. Phosphorus is essential for root development. When the availability is limited, plant growth is usually reduced. In soils that are moderately low in P, onion growth and yield can be enhanced by applied P. Quality of onion can be affected by mineral nutrition, irrigation schedule or rainfall.

In view of the above, the present study was carried out with the objectives to determine the rates of N and P fertilizers for optimum yield of onion in Menschen fÜr Menschen Demonstration Site, Harar Ethiopia, and to assess the growth, and quality of onion grown under varying N and P rates.

Literature Review

Description of onion plant

Onion is an herbaceous biennial monocot grown for its bulb as an annual and only carried forward into a second year when seeds are required. Bulbs are truncate formed from thickened leaf bases, thin and fibrous outer layers, inner layers without blades, up to 10 centimeter in diameter. Leaves are alternate, produced from a flattened conical basal stem, cylindrical, glaucous, becoming hollow. Flowers are borne on a scale, 30-100 centimeter in height, protected by a spathe; terminal umbels produce numerous cymes, each with 5-10 flowers; perianth segments 6, petalloid, green-white, ovate, up to 5mm in length; stamens 6, alternating with perianth segments; ovary superior 3-locular, 2-ovules; style simple, becoming receptive after anther dehiscence. Seeds are smooth, black, wrinkled when dry; embryo curved, germinate epigeal. Fruits capsule in shape and splitting longitudinally [8].

There is wide variation in bulb characteristics of onion [9]. They stated that Bulb weight may be 1 kg in some southern European cultivars, and the shape covers a wide range from globose to bottle-like and to flattened disk-form. The color of the membranous skins may be white, silvery, buff, yellowish, bronze, rose red, purple or violet. The color of the fleshy scales can vary from white to bluish-red. There is also much variation in flavour and keeping or storage ability of the bulbs [9]. Greenwood et al. [10] stated that onion cultivars can have different rooting system. They indicate that maximum average root density was found in the top 20 centimeter of soil but, 90% of the root system was concentrated in the top 40 centimeter soil depth, and only 2-3% of total root was recorded below 60 centimeter depth.

Environmental requirements of onion

Onion is a cool season crop that has some frost tolerance but is best adapted to a temperature range between 13 and 24 **°C**. Optimum temperatures for early seedling growth are between 23 and 27 °C; growth is slowed at temperatures above 30 °C. Acclimated plants are able to tolerate some freezing temperature. The soils used for onions range from light sands to heavy clay loams. Peat soils or sandy soils, if irrigation is available, are preferred and often used. Adequate moisture is critical for uniform seedling emergence. Soils with high water holding capacity are better able to provide moisture to the shallow rooting system but must also drain well to be suitable. Growth is retarded when available soil moisture is low, but onions are also sensitive to a high water table or water logging. Uniform moisture availability about 400-800mm per crop is conducive to large bulb size and high yields. Favorable soil pH is about 6.5 – 8.0 in mineral soils and about 5.8 in peat soils.

Nitrogen

Nitrogen in soils and plants

Nitrogen being the most often growth limiting nutrient is found to be an essential constituent of metabolically active compounds such as amino acids, proteins, co-enzymes and some non-pertinacious ones. Nitrogen comprises 7% of total dry matter of plants and is a constituent of many fundamental cell components. It is one of the most complexes in behavior, occurring in soil, air and water in inorganic and organic forms, and for this reason it poses the most difficult problem in making fertilizer recommendations [11].

Nitrogen constitutes about 5 to 6% of soil organic matter by weight and it is added to the soil both in symbiotic and non-symbiotic forms from the atmosphere. Hence, it plays a vital role in all living tissues of the plant. No other element has such an effect on promoting vigorous plant growth as has N. Abundant protein tends to increase the size of the leaves, and accordingly, brings about an increase in carbohydrate synthesis.

A deficiency of N limits cell division and expansion, chloroplast development, chlorophyll concentration and enzyme activity. Its deficiency symptoms include general stunting and yellowing particularly of older plant parts. Plants absorb N whenever they are actively growing, but they do not always absorb it at the same rate.

Response of onion to nitrogen fertilization

Onion is a heavy feeder, requiring ample supplies of N. Too much N can result in excessive vegetative growth, delayed maturity, increased susceptibility to diseases, reduced dry matter contents and storability and thus, result in reduced yield and quality of marketable bulbs. On the other hand, under sub-optimal supply of N, onions and shallots can be severely stunted, with bulb size and marketable yields reduced. Hence, sub-optimal levels of this nutrient in the soil adversely affect the yield, quality and storability of bulbs of onions and shallots. Onion bulb size is related to planting density and smaller bulbs are formed at closer spacing. However, size can be increased by application of N and potash during growing period.

Large quantities of N fertilizers may be required to obtain high yields of quality onion bulbs, but large amount of N may also remain in the soil after harvest. Generally, the amount of N applied and onion crop responses to N vary from place to place. High yielding varieties usually require more N than low yielding. Results from different climatic regions of the world also show varying responses of onions to applied N. Hence, assessment of the right amount of N fertilizer applied is essential in minimizing the risk of nutrient loss.

Phosphorus

Phosphorus in soils and its availability to plants: Most of the P present in soils is in unavailable forms and added soluble forms of P are quickly fixed by many soils. Thus, available P levels must be supplemented in most soils by adding chemical fertilizers. Unfortunately, much of added P is converted to the less available secondary mineral forms. These secondary forms are released very slowly and become useful to plants only over a period of years.

The dominant form of P available to the plant is $H_2PO_4^-$ and HPO_4^{2-}. However, there is no efficient mechanism in the soil to retain $H_2PO_4^-$ and HPO_4^{2-} ions in large quantities as exchangeable anions. The soluble $H_2PO_4^-$ ion (ortho phosphate) rapidly reacts in the soil to form insoluble phosphates, a process termed as phosphate fixation i.e. precipitation and adsorption. Hence, the accuracy of predicting crop response to P fertilizer application in most soils is often questionable because of the minimal availability of native P to many crops and fixation of fertilizer P in the soil.

Phosphorus requirement of onion

Phosphorus deficiency is one of the largest constraints to crop production in many tropical soils, owing to low native content and high P fixation capacity of the soil [7]. Accordingly, P fertilization is usually recommended in these regions. Phosphorus is essential for root development and when the availability is limited, plant growth is usually reduced. The movement of P in soils is very low and its uptake generally depends on the concentration gradient and diffusion in the soil near roots.

In onions, P deficiencies reduce root and leaf growth, bulb size, and yield and can also delay maturation [12]. In soils that are moderately low in P, onion growth and yield can be enhanced by applied P.

Effects of nitrogen and phosphorus on quality of onion bulb

High N availability affected onion flavor intensity and quality. When solution N levels were varied from 0.22 to 0.97 g L^{-1} in hydrophonic solutions, enzymatically produced pyruvate increased linearly but then decreased at the highest N treatments. MCSO ((+)-S-methyl-L-cysteine sulphoxide)

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increased as N availability increased, while 1-PECO (trans-(+)-S-(1-propenyl)-L-cysteine sulphoxide) initially increased but then decreased at the higher N treatments. PECO generally increased with increasing N levels. Changes in the ACSO (S-alk(en)yl-L-cysteine sulphoxide) concentrations and ratios affected sensory perceptions of onion flavor.

Only little information is available on P effects on quality attributes of onion. Woldetsadik stated that on a clay soil in a sub-humid tropical environment of Ethiopia under irrigation and rainfall condition, the shallot (*Allium ascalonicum*) crop through application of P slightly increased soluble solids, dry matter and pyruvate content of bulbs but the pyruvate content was significantly affected by applied P.

Materials and Methods

Description of the study site

The study was conducted in the Harare National Regional State at Menschen fur Menschen Foundation Agro- Ecology Department demonstration site from March to July of 2015. The experimental site is located on the geographic coordinate of latitude **9°** 20' north and at longitude of 42° 09' east. The altitude of the site is around 1900masl. The mean annual rainfall of the area is 450-1110mm with a bimodal distribution and the average temperature is 11-28 **°C**.

Experimental procedure

Source of seed: The onion seed material was obtained from oromiya farmers' cooperative agricultural input supplier.

Treatment and experimental design

The treatment consisted of a factorial combination of two levels of nitrogen (0, 50 kg N ha-1) and two levels of phosphorus (0, and 75kg $P_2O_5ha^{-1}$). The experiment was laid out in a randomized complete block design with three replications. The sources of N and P are urea (46.7%) and DAP (Di ammonium phosphate (18%), respectively.

After through preparation of land, 12 plots were marked in three blocks (4 plots in each block). The plot size was 2mx2m ($4m^2$), with a distance of 1 meter between plots and 0.5 meter between blocks. Each plot compromised 6 rows with an inter-row spacing of 35centimeter and intra-row spacing of 10centimeter. One row contained 13 plants, and, thus, one plot contained 78 plants

Table 1: Treatments.

Treatments	Treatments code
T1	N_0P_0
T2	N_0P7_5
T3	$N_{50}P_0$
T4	$N_{50}P7_5$

All plants in edge rows were discarding during harvesting. In total, 36 plants were harvested from each plot for determination of yield and yield components

Land preparation and sowing

The first activity of our project was begun by preparing the nursery site with a one meter width and 10 meter length. After constructing the shade an onion seed popularly known as Nantes CV used for the experiment was sown on March, 17, 2015 by hand drilling in rows after mixing them with sand at the ratio of one-to-one on volume basis. After sowing, the seeds were covered with soil about two centimeter depth and applied watering two times per a day during early morning and late afternoon for consecutive days of one week. After one week water was applied only once per a day during late afternoon. Two weeks after emergence, the plants were thinned to an appropriate spacing. Before transplanting the seedling the main field was ploughed three times with a different duration of time. Because the roots of onion seedlings are very small and weak strength so, the main see beds (plots) were smoothened before transplanting. The soil was formed into raise beds to facilitate maximum root growth and reduce soil compaction.

The four treatments were arranged to each plot by using lottery method. The entire rate of the P fertilizers and half rate of the N fertilizers were applied at transplanting date of April, 29, 2015. The remaining half of the N was applied 6 weeks after plant emergence. The fertilizers were uniformly drilled (placed) 5centimeter away from the rows prepared for placing the seedlings and covered with fine soil of about 2centimeter depth and applied watering. Seedlings of the onion were planted at the borders to have additional onion plants for avoiding edge effects. All cultural practices such as weeding, disease, and pest control, cultivation and supplementary irrigation was performed uniformly during the duration of growth.

Crop data collection

Data on growth parameters and bulb characters were recorded at physiological maturity and harvesting. The collected data were expressed as average of five plants were randomly selected from each plot and tagged for measuring values at more of these crop data. Tagging of plants to be sampled was carried out by attaching colorful strings to make the plants conspicuous so as to distinguish them from other plants in the population during data collection.

Accordingly, plant height was measured in centimeter from the ground level to the top of mature leaf at half physiological maturity (May, 17, 2015) on five randomly selected samples. Total number of Active leaf petioles were counted and recorded at 50% physiological maturity on the five randomly selected sampled plants of each plot of each treatment. The length of the longest leaf was measured with the help of meter scale to determine leaf length.

Thirty six randomly sampled plants were harvested from the central rows of each plot by excluding the edges of each four sampled rows and their bulb weight was measured immediately using analytical balance and the mean weights was calculated. Before weighting the bulbs, soil dirt and other foreign matter are carefully isolated from plants to obtain correct values of the bulb weight. The length of five random onion bulbs of the harvested plants of each plot was measured using ruler. The diameter of five onion bulb obtained from the five randomly harvested plants of each plot was measured at the widest portion of the bulb using a rope. While neck thickness was measured at the narrowest point using rope.

Marketable bulbs were separated from the total yield, count and weigh to determine the marketable weight. Bulbs from the total yield that were found to be under or over-sized, forked, hairy, cracked, cut, rotting etc., was grouped under the category of unmarketable bulbs. The unmarketable bulbs were weighted.

Statistical analysis

The analysis of variance (ANOVA) of the data was analyzed manually using the standard procedure. The absolute value of the treatment means differences were compared with the least significant difference (LSD) test value with a 5% error level.

Results and Discussion

Plant height, leaves per plant, leaf length and diameter

Application of N fertilizer highly significantly influenced plant height of onion grown in Menschen für Menschen Demonstration Site while P fertilization and their interaction did not affect this parameter. Application of 50 kg N ha^{-1} brought about 10.46% (28.62 centimeter) increments in plant height as compared to the control (25.91 centimeter). The increase in height could be attributed to the fact that N is one of the important building blocks of amino acids (-NH_2), where they link together and form proteins and make up metabolic processes required for plant growth. Bungard et al. stated that N is a constituent of many fundamental cell components and plays a vital role in all living tissues of the plant. No other element has such an effect on promoting vigorous plant growth. This result is in harmony with those reported by Rizk who concluded that increasing the application rate of N increased growth parameters of onion plant. Similarly, N fertilization has significantly ($p \leq 0.05$) influenced number of leaves produced by onion plant

However, P fertilization and the interaction effect of N and P did not significantly ($p > 0.05$) affect leaf number of onion. Number of leaves increased by about 8.59% (4.66 centimeter) in response to the application of 50 kg N ha^{-1} over the control. This could be attributed to the increase in the vegetative growth of the onion plants through the effect of N in the synthesis of the different components of protein through increased production of carbohydrate in the plant system. Similar result was also reported by Nasreen et al. [13] who found that application of 120 kg N ha^{-1} significantly increased the number of leaves per plant and further increase in the level of N (160 kg ha^{-1}) tended to decrease it. Similarly, Vachhani and Patel [14] found that number of leaves per plant was the highest with the application of 150 kg N ha^{-1}.

Without affecting leaf diameter, N fertilization highly significantly increased leaf length in onion (Table 2).

Table 2: Effects of increasing rates of N and P on plant height, number of leaves, leaf length and diameter of onion grown at Menschen fÜr Menschen Demonstration Site Harar, ETHIOPIA.

Treatments	Plant height (centimeter)	Leaves per plant	Leaf length (centimeter)	Leafdiameter (centimeter)
Control	25.91	4.26	28	7.8
50 kg ha^{-1} N Source of Urea	28.62	4.66	29.73	7.76
75 kg ha^{-1} P Source of DAP	24.22	4.33	27.16	7.973
50 kg ha^{-1} N &75 kg ha-1 P Source of Urea& DAP	26.46	4.13	27.4	7.74
SE(±)	0.78	0.14	0.33	0.32
SD(±)	1.1	0.2	0.46	0.46
CV (%)	5.19	5.63	2.01	0.72
LSD (5%)	2.69	0.49	1.12	1.13

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Leaf length was not significantly ($p > 0.05$) influenced by P fertilization as well as its interaction with N. The application of 50 kg N ha-1 increased leaf length by about (29.73 centimeter) by about 5.82% as compared to the control (28 centimeter). The positive effect of N on leaf length may be due to the role it plays on chlorophyll, enzymes and proteins synthesis. The result is in agreement with Bungard et al. who described that N is the major constituent of proteins and the presence of abundant protein tends to increase the size of the leaves, and accordingly, bring about an increase in carbohydrate synthesis. Similar result was also reported by Jilani who found that N at the rate of 200 kg ha^{-1} enhanced the length of onion leaves.

In general, onion plant height, leaves number and length were not significantly affected by P fertilization. The lack of response to applied P could be attributed to the presence of adequate amounts of available P in the soil for normal growth of the crop. In soils that are relatively low in P, onion growth and yield can be enhanced by applied P [15]. In the presence of sufficient irrigation or moisture, onion could benefit from the available P high rate of diffusion.

Neck thickness, bulb diameter and length

P fertilization and their interaction to N did not significantly ($p > 0.05$) affect the formation of thick-necked bulbs in onion. This could be due to the minimal direct effect of fertilization in the formation of thick-necked bulbs. In favor of our finding, Brewster et al. reported that neck-thickness is a physiological disorder that is influenced by seasons, sites and cultivars. In contrast, Jilani reported that application of N at 200 kg ha^{-1} enhanced the number of thick-necked bulbs.

Nitrogen fertilization highly significantly increased bulb diameter without affecting bulb length (Table 3). On the other side, P fertilization and its interaction did not significantly influence both bulb diameter and length. Application of 50 kg ha^{-1} N increased bulb diameter by about 19.81% (8.73 centimeter) as compared to the control (7 centimeter). This could be due to the activities of N in different physiological and metabolic processes through increase in dry matter production. This was in agreement with Nasreen et al. [13] who reported a significant increase in the diameter of bulbs due to application of N up to 120 kg $ha^{-1.}$ Although N fertilization did not affect bulb length in this study there are findings disclosing an increased bulb length in response to N fertilization (Table 3).

Total and marketable bulb yields

The analysis of variance indicated that N had significantly affected the total and marketable bulb yields of onion (Table 4).

Table 3: Effects of increasing rates of N and P on neck thickness, split bulbs, bulb diameter and length of onion grown in Menschen fÜr Menschen Demonstration Site, Harar ETHIOPIA.

Treatments	Neck thickness (centimeter)	Bulb diameter (centimeter)	Bulb length (centimeter)
Control	3.8	7	6
50 kg ha-1 N Source of Urea	4.03	8.73	5.13
75 kg ha-1 P Source of DAP	3.73	6.17	7.73
50 kg ha-1 N &75 kg ha-1 P Source of Urea& DAP	3.74	6.4	5.4
SE(±)	0.06	0.33	0.33
SD(±)	0.08	0.26	0.46
CV (%)	2.62	7.99	9.31
LSD (5%)	0.19	0.64	1.13

Table 4: Total and marketable fresh bulb yield of onion as affected by different rates of N and P grown in Menschen fÜr Menschen Demonstration Site, Harar ETHIOPIA.

It was observed that application of N has pronounced effects on both total and marketable bulb yields of onion.

Treatments	Fresh Bulb yield (kg per plot)	
	Total	Marketable
Control	2	1.08
50 kg ha-1 N Source of Urea	3.72	2.73
75 kg ha-1 P Source of DAP	1.66	0.42
50 kg ha-1 N &75 kg ha-1 P Source of Urea& DAP	1.4	0.4
SE(±)	0.33	0.26
SD(±)	0.46	0.37
CV (%)	27.33	0.24
LSD (5%)	1.12	0.91

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Application of N at a rate of 50 kg ha^{-1} increased the total and marketable bulb yields by about 46.2 and 60.4%, respectively, as compared to the untreated control (1.43 and 0.001 tons ha^{-1}, respectively). In both cases however, further increase in N rate did not bring significant effect suggesting 50 kg ha^{-1} is the optimum rate to obtain highest marketable and total bulb yield of onion in Menschen fÜr Menschen Demonstration Site, Harar, Ethiopia. This positive response may be due to the role of N in promoting the growth of onion plant.

Phosphorus and the interaction effect of N and P did not significantly ($p > 0.05$) influence the total and marketable bulb yield of onion

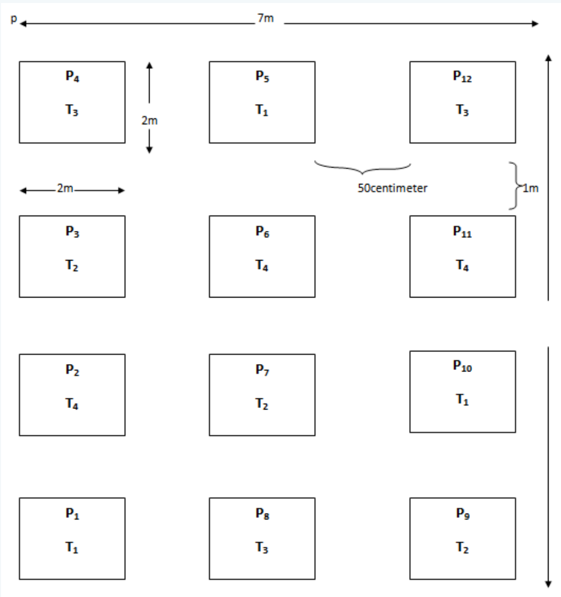

Figure 1: Experimental design that was constructed in Menschen fÜr Menschen Demonstration Site, Harar ETHIOPIA.

T: Treatment; Seed rate: 2.5-3.4kg/ha; B: Block; Net Seed required: 36.72gm; P: Plot; Plot size: 4m2; Between plot: 0.5m; Between Block: 1m; Plot Size: 2mx2m; Number of row/plot: 6; Number of plant/row: 13; Number of plant/plot: 78

The lack of response to P in this study suggests that the amount of P present in the soil was adequate for the crop. Besides, the pH of the initial soil was also suitable for the uptake of available P found in the soil.

Summary and Conclusion

The study was conducted at Menschen für Menschen demonstration site from the growing season of March to end of July, 2015. The water requirement for the experimental crop was fulfilled by application of it manually using watering cane for the first two months while for the remaining period it was fulfilled by natural rain. The major objectives of these studies were to determine the optimum rates of N and P fertilizers for yield of onion on in Menschen für Menschen demonstration Site and to assess the growth, and quality of onion under varying levels of N and P fertilizers. The experiment consisted of factorial combination of two rates of N (0&50 kg N ha^{-1}) and two rates of P (0&75 kg P ha-1) arranged in randomized complete block design with three replications. Data were recorded both on plant and plot basis for growth and yield of onion.

Nitrogen had significant effects in all of the growth and bulb characters except leaf diameter, and bulb length of onion grown on in Menschen fÜr Menschen demonstration Site, Harar Ethiopia. Phosphorus and the interaction effect of N and P did not affect any of the growth and bulb characters.

Application of 50 kg N ha^{-1} brought about 10.46% plant height increment compared to the control (25.91 centimeter). This could be attributed to the role of N as it is one of the important building blocks of amino acids, as they link together and form proteins and make up metabolic processes required for increase in plant growth. Similarly, number of leaves increased by about 8.59% in response to the application of 50 kg N ha^{-1} over the control. Without affecting leaf diameter, N fertilization significantly increased leaf length and application of 50 kg N ha^{-1} increased leaf length by about 5.82% over the check (28 centimeter) that may be linked to its role on chlorophyll, enzymes and proteins synthesis. In general, onion plant height, leaves number and length were not significantly affected by P fertilization. The lack of response to P could be attributed to the presence of adequate amounts of available P in the soil.

P fertilization and their interaction did not significantly affect the formation of thick-necked bulbs of onion. This could be due to the minimal direct effect of fertilization in the formation of thick-neck bulb. Application of 50 kg N ha^{-1} (8.73 centimeter) increased the bulb diameter by about 19.81% as compared to the control (7 centimeter) without affecting bulb length. This could be due to the activities of N in different physiological and metabolic processes through increasing in dry matter production.

Nitrogen had significantly increased the average bulb weight of onion. There was 46.2 % average bulb weight increment in response to the N treatments, regardless of the rates. This may be attributed to the increase in plant height, number of leaves per plant and leaf length, which have direct effects on dry matter production

Although the experiment was conducted in one site and for one season, it is reasonable to point out that application of N at the rate of 50 kg ha^{-1} gave optimum total and marketable bulb yields without significantly influencing the quality of onion grown in Menschen für Menschen demonstration site area. The application of P fertilizer is not advisable as the soil has adequate level for normal onion crop. However, using this information as spring board, further investigations (including N rates below

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and above 50 kg ha^{-1}) are needed to arrive at a sound fertilizer recommendation.

Dedication

This research project manuscript is dedicated to our late father Dr. Karlheinz Bohm who devoted his entire life until he rest for disadvantaged Ethiopian People.

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tropical countries. Purple fruits have higher amino acid content. Brinjal fruits have medicinal properties Rajan and Markose [3]. Some medicinal use of eggplant tissues and extract include treatment of diabetes, asthma, cholera, bronchitis and diarrhoea, its fruit and leaves are reported to lower certain levels of blood cholesterol. The growth, yield and fruit quality of brinjal are largely dependent on number of interacting factors. On the other hand egg plant is a long duration crop with high yield which removes large quantities of nutrients from the soil. An egg-plant crop yielding 60t ha^{-1} of fruit removes 190kg N, 10.9kg P and 128kg K from soil [4]. Now-a-days demand for brinjal as a fruit vegetable is increasing rapidly among the vegetable consumers in view of its better fruit color, size and taste. Average productivity of brinjal crop is quite low and there exists a good scope to improve its average productivity in India to full fill both domestic and national needs. Only one source of nutrients like chemical fertilizers, organic manures and biofertilizers cannot improve the production or maintain the production sustainability and soil health. The integrated nutrient management is very useful in this context. Integrated plant nutrient management is the intelligent use of optimum combination of organic, inorganic and biological nutrient sources in a specific crop, cropping system and climatic situation so as to achieve and to sustain the optimum yield and to improve or to maintain the soil's physical, biological and chemical properties. Such a crop nutrition package has to be technically sound, economically attractive, practically feasible and environmentally safe [5].

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