Advances in Crop Science and Technology
ISSN: 2329-8863

Hypothesis Open Access

Growth and Economic Analysis of Different Nitrogen and Phosphorus fertilizer rates on Onion seed (*Allium cepa L.*) South Eastern Ethiopia

Demis Fikre Limeneh*

Ethiopian Institute of Agricultural Research, Kulumsa Research Center, Assela, Ethiopia

Abstract

Onions are the second most valuable vegetables in the world, following tomato. Its production is constrained by a number of problems including declining soil fertility and inappropriate fertilizer application. A study was conducted to determine economical optimum rates of N and P fertilizers for onion seed production in Arsi area. The experiment was conducted at Kulumsa, South Eastern Ethiopia, using four different levels of N (0, 50,100 and 150 kg N ha^{-1}) and four levels of P (0, 35, 70 and 105 kg P2O5 ha^{-1}) fertilizers arranged in 4 X 4 factorial arrangements in randomized complete block design with three replications. The result of the study revealed that almost all growth parameters considered were significantly affected by the treatments. The crop phenology and growth components were significantly influenced by the rate of N and P fertilizers. The combination of N at 100 kg N ha^{-1} and P at 70 kg P2O5 ha^{-1} was promising combination that generated highest net benefit 488,878.5 ETB ha^{-1} with the highest marginal rate of return (36638%). Therefore, a combined application of N at 100 kg N ha^{-1} and P at 70 kg P2O5 ha^{-1} rates can be recommend for onion seed famers in the study area and areas of similar agro-ecology.

Keywords: Onion; Plant growth; Nitrogen; Phosphorus; Partial budget

Introduction

Onion belongs to the genus Allium of the family Alliaceae and is one of the oldest cultivated vegetable, for over 4000 years (Hanelt, 1990). It is probably originated in central Asia between Turkmenistan and Afghanistan where some of its relatives still grow as wild plants (Zohary and Hopf, 2000). 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 (Grubben and Denton, 2004) [1].

Onion is an herbaceous biennial monocot cultivated as an annual. Onion being a biennial crop, takes two seasons for seed production. During the first season bulbs are formed while flower stalks and seeds are developed in the second season. Onion is grown mainly for their bulbs, although the green shoots of salad. Onions are usually grown from seed, and flowering and seed production are important for crop production (Brewster, 2002) [2].

Onions are the second most valuable vegetables in the world, following tomato. The production of onion crop is worldwide because of its wide benefits in our daily foods requirements. Onion is largely produced in the developed nations and has dominated in the international markets due to its higher quality production and longer storage life (Opara, 2003). It is estimated that around the World, over 3,642,000 ha of onions are grown annually. On a worldwide scale, around 80 million metric tons of onions are produced per year [3]. China is by far the top onion producing country in the world, accounting for approximately 28% of the world's onion production, followed by India, USA, Iran, Egypt, Turkey, Russia, Pakistan, Netherlands and Brazil. The worldwide onion exports are estimated at around 7 million Metric tons. The Netherlands is the world's largest onion exporter with a total of around 220,000 Metric tons followed at a distance by India (FAO, 2013). In Africa, Egypt is the leading country by producing 22.08 million tons of onion per year for domestic and international markets that rank as the fourth of world producer (Kulkarni et al., 2014) [4].

Onion is currently becoming a popular vegetable crop despite to its recent introduction to the country because of its yield potential per unit areas, the ease of propagation method both by seed and bulb method, and the presence of high domestic and export markets (Lemma and Shimeles, 2003; Dawit et al., 2004; Ashenafi et al., 2014; Asfaw and Eshetu, 2015). Onion is more widely grown in Ethiopia for local consumption and for flower export. It contributes significant nutritional values to the human diet and has medicinal properties and is primary consumed for its unique flavors or for its ability to enhance the flavors of other foods (Lemma and Shimeles, 2003) [5].

In Ethiopia, at present different vegetable crops are produced in many home gardens and also commercially in different parts of the country (Fekadu and Dandena, 2006). Among these vegetables, onion is one of the most important cash crops. Onion production also contributes to commercialization of the rural economy and creates many off-farm jobs (Lemma and Shimeles, 2003; Nikus and Fikre, 2010) [6].

Onion seeds are well known to be highly perishable and poor in keeping quality and lose viability within a year. One of the problems of onion production in the tropics is lack of seed which is true to type with high germination and vigor (Currah and Proctor, 1990; Griffiths et al., 2002). Onion seed is usually produced in the temperate and subtropical countries [7].

Seed production is one of the most important and potential area in onion production that can bring a high economic benefit for small scale farmers. Most tropical countries near the equator import much of their onion seeds because temperature is not cool enough to induce optimal

***Corresponding author:** Demis Fikre Limeneh, Ethiopian Institute of Agricultural Research, Kulumsa Research Center, Assela, Ethiopia; P.O. Box-489; Email: fikredemis@gmail.com

Received: 01-Dec-2023, Manuscript No: acst-23-123430, **Editor Assigned:** 04-Dec-2023, pre QC No: acst-23-123430 (PQ), **Reviewed:** 18-Dec -2023, QC No: acst-23-123430, **Revised:** 22-Dec-2023, Manuscript No: acst-23-123430 (R), **Published:** 29-Dec-2023, DOI: 10.4172/2329-8863.1000652

Citation: Limeneh DF (2023) Growth and Economic Analysis of Different Nitrogen and Phosphorus fertilizer rates on Onion seed (*Allium cepa L.*) South Eastern Ethiopia. Adv Crop Sci Tech 11: 652.

flowering. However, there is also possibility of producing onion seed using artificial Vernalization (Kimani et al., 1994). In Kenya, research conducted on three local and eight introduced onion cultivars showed that bulbs stored at 10°C flowered earlier than those stored at other temperatures and those stored at 21.9°C were the latest to flower (Kimani et al., 1994). In Ethiopia, temperature of 9-17°C was indicated to be favorable for flower stalk development and seed production (Lemma, 1998) [8].

The price of onion botanical seed remains high in the season of onion cultivation. Seed is the basic and essential input for any crop production (Karim et al., 1999). Seed production is a vital part in onion growing and is highly specialized business (FAO, 2013). The yield of onion seed in our country varies from $1000^{-1}300$ kg ha^{-1} (Lemma et al., 2006), $116.32^{-1}18.2$ kg ha^{-1} (Tamrat, 2006), $75.15^{-1}155.75$ kg ha^{-1} (Teshome et al., 2014) and 748.9-879.4 kg ha^{-1} (Getachew, 2014) which is very low compared to the average seed yield in some other countries of the world, 600-2000 kg ha^{-1} (Chadha et al., 1997) and $828^{-1}446$ kg ha^{-1} (Aminpour and Mortzavi, 2004) [9].

Reports indicated that the low yield of onion seed in the country is due to low fertility of soil, inappropriate fertilizer use, lack of improved varieties, and poor management practices (Lemma and Shimelis, 2003). Among these constraints, inappropriate use of mineral fertilizer was one of the most important management factors in Arsi Zone. In the district, 150 kg urea ha^{-1} and 200 kg DAP ha^{-1} was traditionally used, which was recommended by Melkassa Agricultural Research Center for bulb production at national level (Lemma and Shimelis, 2003). However, these recommendations cannot be directly adopted for the soil and growing conditions of the Arsi Zone, which are different from the conditions in the Rift Valley region. There is no site specific recommended rate of fertilizers for onion production in Arsi Zone [10,11].

The majority of the farmers in the district, however, use smaller doses of N and P fertilizers. Some of the farmers use higher doses of N fertilizer only in the form of urea and others do not use P fertilizer at all. The optimum rates of N and P is not determined to produce high and quality seed yield of onion. Application of appropriate rate and type of fertilizers are vital operations for high seed yield and quality of onions [12].

In order to fulfill the high demand of onion seed in Arsi Zone, high quality seed has to be produced locally in large quantity at reduced cost of production for commercial seed and bulb producers. This not only answers the local demand for onion seed but also reduces dependency on imported seed from abroad. Therefore, this research was conducted with the following objective: to determine economical optimum rates of N and P fertilizers for onion seed production in Arsi area.

Materials and Methods

Description of the study area

The study was conducted at Kulumsa Agricultural Research Center (KARC) which is located at 8°00' to 8°02'N and 39°07' to 39°10'E with an elevation of 2210 m. a. s. l. in Tiyo district, Arsi Administrative Zone of the Oromia Regional State. The site is found 167 km South East of Addis Ababa [13]. The research center is located on a very gently undulating topography with a gradient of 0 to 10% slope. It has a low relief difference with altitude ranging from 1980 to 2230 meters .The agro-climatic condition of the area is wet with 811 mm mean annual rain fall and it is a uni-modal rainfall pattern with extended rainy season from March to September. However, the peak season is from July to August. The mean annual maximum and minimum temperatures are 23.1 and 9.9°C, respectively. The coldest month is December whereas May is the hottest (Abayneh et al., 2003). The weather data recorded during 2017 indicated that the area received a total annual rainfall of 838.2 mm. The rainfall pattern is uni-modal with extended rainy season; from February to October. However, the peak rainy season is from July to September (Figures 1 and 2). The average annual minimum and maximum temperatures were 11.7 and 23.9 °C, respectively [14].

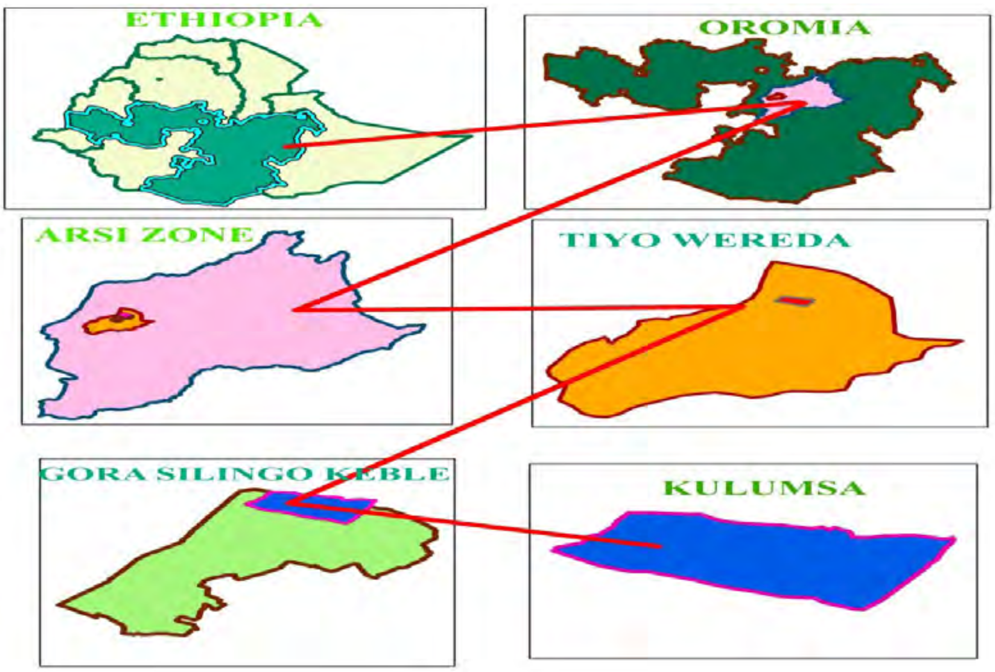

Figure 1: Location map of the study area.

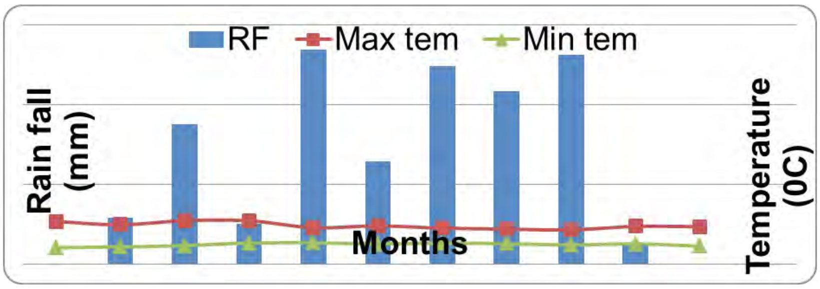

Figure 2: Mean monthly rain fall, maximum and minimum temperature of the study area in 2017/2018.

Experimental materials and bulb production

Seedlings of onion cultivar Nafis were raised in the seed bed at Kulumsa Agricultural Research Center (KARC) in March 2017. After 45 days, seedlings were transplanted to the field at (KARC) for bulb production. Seedlings were transplanted with a recommended spacing of 40 cm x 20 cm x 5 cm. All the recommended agronomic and crop protection practices such as cultivation, fertilization, weeding and pesticide application were deployed. Once the onion is matured, bulbs were harvested and true to type bulbs which are healthy, well-shaped and size were selected for the experiment. Selected bulbs were stored at 15°C and kept under ambient temperature for about one month and half until it broke the dormancy and started sprouting [15].

Experimental design and procedure

The Experimental field was cleared and ploughed three times by tractors plough according to Kulumsa Agricultural Research Center Practice and after which it was divided into three uniform blocks each containing 16 plots for each treatment. The sprouted onion bulbs were planted in double rows with spacing of 50, 30 and 20 cm between water furrows, rows and plants in rows, respectively. Distances of 1 m and 1.5 m were maintained between plots and blocks, respectively. Each plot had four rows (ridges) which consisted of 112 plants. The middle double rows were considered for recording of agronomic data [16].

The experiment was conducted under irrigation condition during the off-season of October 2017 to May 2018. The treatments consisted of four levels of N (0, 50, 100, and 150 kg ha^{-1} from urea (46-0-0) and four levels of P2O5 (0, 35, 70, and 105 kg ha^{-1} from TSP (0-46-0) in a 4 x 4 factorial combinations. The treatment combinations were arranged in randomized complete block design (RCBD) with three replications. A plot size of 3.2 m x 2.8 m (8.96 m2) was used for each experimental unit (plot). Treatments were randomly assigned to the experimental plots of each replication. The full dose of P applied at planting and half dose of N fertilizer were applied two weeks after planting and the remaining half dose of N was side-dressed forty five days after planting [17].

Other cultural practices

The plots were irrigated as per the recommendation for the area, i.e. at the interval of four days during the first phase of active growth of the plant. Later, the irrigation gap was increased to seven days interval. Hoeing was done manually and the field was kept free of weeds during the growing period. For the control of disease and insect pests, insecticides such as Profit (3 liters ha^{-1}), Agrolambex, and fungicide chemicals Ridomil (3.5 kg ha^{-1}) were used. Harvesting of umbels in the net plot area was done by a sharp sickle at maturity of the umbel per each plot. It was started on March 9, 2018 and ended on May 15, 2018. The umbels were dried on canvas and threshed by hand. The seeds were separated from stalks and other debris by winnowing [18] (Table 1).

Table 1: Treatment rates of nitrogen and phosphorus fertilizer rates.

Nitrogen Rate	Phosphorus Rate (P_2O_5)
0 kg N ha^{-1}	0 Kg P_2O_5 ha^{-1}
50 kg N ha^{-1}	35 Kg P_2O_5 ha^{-1}
100 kg N ha^{-1}	70 Kg P_2O_5 ha^{-1}
150 kg N ha^{-1}	105 kg P_2O_5 ha^{-1}

Data collection and measurement

Crop phenology and growth parameters: Days to maturity: It was recorded as the number of days from date of planting up to when 50% of the plants in each plot matured or ready for harvest (when 90 % of the seed colour changed to black or the capsule turned brown and started splitting or physiologically matured).

Flowers Stalk height (cm): was recorded by measuring the plant from the leaf emerged to the tip of flower stalk under the flower head.

Number of flowers per umbel: The numbers of flowers in each umbel was counted from randomly selected six umbels at maximum flowering stage in each plot [19].

Partial budget analysis: Partial budget analysis was employed for economic analysis of fertilizer application and it was carried out for combined seed yield data. The potential response of crop towards the added fertilizer and price of fertilizers during planting ultimately determined the economic feasibility of fertilizer application. The economic analysis was computed using the procedure described by (CIMMYT, 1988)

Gross average seed yield (kg ha^{-1}) (AvY): is an average yield of each treatment

Adjusted yield (AjY): is the average yield adjusted downward by a 10% to reflect the difference between the experimental yield and yield of farmers (CIMMYT, 1988) [20].

AjY = AvY-(AvY-0.1)

Gross field benefit (GFB): was computed by multiplying field/farm gate price that farmers receive for the crop when they sale it as adjusted yield.

Total cost: is the cost of Urea and TSP used for the experiment. Their prices were based on 2017 price during planting. The costs of other inputs and production practices such as labor cost for land preparation, planting, weeding, crop protection, and harvesting were assumed to remain the same or the difference were insignificant among treatments [21,22].

Net benefit (NB): was calculated by subtracting the total costs from gross field benefits for each treatment. NB = GFB-total cost

Marginal rate of return (MRR %): was calculated by dividing change in net benefit by change in cost which is the measure of increasing in return by increasing input.

Marginal rate of return (%) = (change in net benefit)/ (Change in total cost)*100

Result and Discussions

Days to maturity

The main effects of nitrogen (N) and phosphorus (P) fertilizers significantly ($P<0.01$) affected days to maturity of onion. However, the interaction effect of N and P fertilizers was not significant ($P>0.05$).

All levels of N fertilizer delayed maturity of onion as compared to the control treatment (no N fertilizer). Days to maturity was delayed most at the highest rate of N fertilizer (150 kg ha^{-1}) but this was not significantly different from 100 kg N ha^{-1} (Table 2). Days to maturity increased by about 3.27 and 3.92% in response to the fertilization of 100 and 150 kg N ha^{-1}, respectively as compared to the control treatment [23]. The delay in maturity in response to N fertilizer application could be due to the fact that N fertilization increases the vegetative growth of plants and an essential nutrient for plant development and reproduction (Marschner, 1995). Nitrogen is a significant component of nucleic acids such as DNA, the genetic material that allows cells (and eventually whole plants) to grow and reproduce [24]. This is in agreement with the findings of Brewster (1994) and Sørensen and Grevsen (2001) who reported that too much N can result in excessive vegetative growth and delayed maturity. This result is consistent with the findings of Meena et al. (2007), Abdissa et al. (2011), Morsy et al. (2012) and Guesh (2015) who reported that maturity of onion plants was delayed in response to increasing nitrogen application. According to Kiros et al. (2018) seed maturity was significantly delayed when grown at 100% of 69 kg N and 92 kg P2O5 ha^{-1} fertilizer (133.3 days), a delay of 4 to 6 days compared to lower NP rates and the control treatments [25].

The numbers of days taken for maturity of onion were significantly reduced when 105 kg P2O5 ha^{-1} was applied as compared to the control treatment. However, this treatment was not significantly different from the other treatment received 70 kg P2O5 ha^{-1} [26]. The maturity of onion was delayed at the control treatment (no P fertilizer) and P at a rate of 35 kg P2O5 ha^{-1}. Application of Pat rate of 105 kg P2O5 ha^{-1} reduced days to maturity by 4 days as compared to control treatment. The early maturity effect of phosphorus application may be related to the phosphorus effect that initiated early flowering. Since phosphorous is a part of the structure of DNA, RNA, ATP and phospholipids in membranes it plays an important role in basic plant carbohydrate metabolism and energy transfer systems. So, it is known that, adequate P application leads to a general increment of most metabolic processes including cell division, cell expansion, respiration and photosynthesis. And by shortening the vegetative growth of a crop it could play an important role to hasten physiological activities (Hinsinger, 2001) [27].

In conformity with the present result, application of P has been reported to hasten maturity of onion crops (Tamrat, 2006). However, contradicting reports are also available which indicate non-significant effect of P fertilizer on the maturity of onion (Getachew, 2014). This contradicting result could be due to soil variability, planting season, moisture levels, and variety to response fertilizers, light energy, biotic factors or other environmental factors affecting the influence of P fertilizer [28].

Table 2: Main effect of nitrogen and phosphorus fertilizers rates on phenology and yield of onion grown at kulumsa.

Treatment N (kg ha^{-1})	Days to maturity	Number of flowers per umbel	Flower stalk Height(cm)
0	165.33c	302.23b	7.27c
50	168.50b	357.27b	8.82b
100	170.92ab	426.73a	12.14a
150	172.08a	459.06a	12.83a
SE±	3.06	71.2	0.95
LSD(0.05)	2.55**	59.37**	0.79**
P2O5(kg/ha)			
0	170.50ab	320.58c	8.81b
35	170.83a	380.16b	9.27b
70	168.08bc	403.52ab	11.42a
105	166.92c	441.03a	11.57a
SE+	3.06	71.2	0.95
LSD(0.05)	2.55*	59.37**	0.79**
CV (%)	1.81	18.43	9.22

LSD (5%) = least significant difference at P=0.05, CV (%) = Coefficient of variation ns= non-significant. Means in columns with the same letter(s) in each treatment are not significantly different

Number of flowers per umbel

Numerically the highest number of flowers per umbel was obtained when N was applied at the rate of 100 kg ha^{-1} which was statistically at par with N at rate of 150 kg ha^{-1}. The lowest number of flowers per umbel was recorded in the control treatments. Other report on onion indicated that application of N has been found to increase the number of umbels per plant and number of florets per umbel (Ahmed and Abdalla, 1984). The highest number of flowers (198.31) was obtained from 150 kg N ha^{-1} applied and the lowest (138.79) form control (Ali et al., 2007). According to Abas et al. (2015) nitrogen fertilization significantly increased number of flowers per umbel [29,30].

Similarly the number of flowers per umbel was affected by P fertilizer. The highest number of flowers per umbel was obtained when P was applied at the rate of 105 kg P2O5 ha^{-1} which was statistically at par with 70 kg P2O5 ha-The lowest number of flowers per umbel was recorded from the control treatments. From the result the number of flowers per umbel increased at higher rates of both N and P fertilizers. This very important character increased by P application probably due to the fact that this element was vital for flowering, seed formation and related reproductive activities (Brady and Weil, 2002). This result is in concordant with the findings of Muhammad et al. (1999) who reported that the highest (618.0) number of flowers per umbel was recorded by the application of N at rate of 75 kg ha^{-1} and P 46 P2O5 kg ha^{-1} and the lowest (523.80) was recorded from control plots. The number of flower stalks per plant varied from1 to 15 per plant at Melkassa and the terminal number of 50-200 flowers produced per umbel on "Adama Red" depending on the number of shoots axis (Lemma, 1998). In onion there were commonly 200 to 600 flowers per umbel (Brewester, 2008).

Flower stalk height

Flower stalk height was significantly ($P<0.05$) influenced only by the main effect of nitrogen (N), but phosphorus (P) fertilizer and their interaction was not significant ($P>0.05$).

The highest flower stalk height was recorded for N application at a rate of 100 kg ha^{-1} and this was statistically similar with N at rate of 150 kg ha^{-1}. The lowest flower stalk height was obtained from the control treatments. Application of N at 100 kg ha^{-1} brought by about 11.58% increments in flower stalk height as compared to the control. Nitrogen is so vital because it is a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide (i.e., photosynthesis). This increment of height by applied N in part could be due to major factor of N contributing to the higher rates of vegetative growth and stem elongation when nitrogen fertilizers are applied to the plants (Marschner, 1995; Gupta and Sharma, 2000). But P fertilization did not affect flower stalk heights. The result was in accordance with Sidhu et al. (1996), Tamrat (2006) and Debashis et al. (2017) who found stalk heights for other cultivar of onion in the range of 76-93 cm which was similar to height recorded in the present study. According to Abas et al. (2015) nitrogen fertilization significantly increased the length of flowering stalk [31].

Partial budget analysis

A partial budget is a way of calculating the total costs that vary and the net benefits of each treatment (CIMMYT, 1988). From this study, the average yield of 16 treatments was obtained. According to CIMMYT (1988), the average yield was adjusted down wards by 10%. This is for the reason that, researchers have assumed that using the same treatments the yields from the experimental plots and farmers' fields are different, thus average yields should be adjusted downward. Based on this, the recommended level of 10% was adjusted from all 16 treatments to get the net yield.

For the different treatment combinations the total costs and net benefits were calculated. As the rate of N and P fertilizer application increased, each additional kilogram of the fertilizer had effect on seed yield. To estimate the total costs, mean current prices of Urea and TSP were collected at the time of planting and market price value of one kg of onion seed was taken at harvest. The cost for daily labor during the season was 50 birr per day. The field price of onion seed during the harvesting season was 330 birr kg^{-1}. Then finally, adjusted yield was multiplied by field price to obtain gross field benefit of onion. All the variable costs were subtracted from gross benefit to obtain net benefit [32].

The result of the economic analysis showed that highest net benefit 488,878.5 ETB ha^{-1}, highest rate of marginal returns 36638% and highest benefit cost ratio 7.66 were obtained from combined application of 100 N and 70 kg P2O5 ha^{-1}. It was followed by 50 N and 105 P2O5 kg ha^{-1} N and P fertilizers which had 429,525 ETB ha^{-1} net benefit, 27910% rate of marginal return and 6.74 benefit cost ratio (Table 3). This indicated that as the total costs that vary increased until certain level, so as the net benefit obtained increased. However, as the total costs that vary increased over the optimum level, the net benefit obtained reduced as the result of higher variable costs associated with lower earnings. The cost of onion seed was exceptionally medium 330 birr per kg from normal market which was 260 birr per kg when the produce was collected and this was one reason for medium net benefit recorded in this study. According to CIMMYT (1988) economic analysis based fertilizer recommendation is not necessarily based on the treatment with the highest marginal rate of return compared to that of the next lowest cost, the treatment with the highest net benefit, and nor the treatment with the highest yield. The identification of a recommendation is based on a change from one treatment to another if the marginal rate of return of that change is greater than the minimum rate of return (100%).

Dominance analysis, net benefit curve and marginal rate of return

The highest net benefits from the application of inputs for the production of the crop might not be sufficient for the farmers to accept as good practices. In most cases, farmers prefer the highest profit with low cost (high income). For this purpose it is necessary to conduct dominated treatment analysis. A dominated treatment is any treatment that has net benefits that are less than those of a treatment with lower costs that vary (Stephen and Nicky, 2007). The Dominance analysis procedure as detailed in CIMMYT (1988) was used to select potentially profitable treatments from the range that was tested. The dominant (undominated) treatments were ranked from the lowest to the highest costs that vary. The dominant analysis showed that the net benefit of 50 kg N ha^{-1} + 0 P2O5 kg ha^{-1}, 50 kg N ha^{-1} + 35 P2O5 kg ha^{-1}, 100 kg N ha^{-1} + 0 P2O5 kg ha^{-1}, 0 kg N ha^{-1} + 105 P2O5 kg ha^{-1}, 150 kg N ha^{-1} + 35 P2O5 kg ha^{-1}, 100 kg N ha^{-1} + 105 P2O5 kg ha^{-1}, 150 kg N ha^{-1} + 0 P2O5 kg ha^{-1}, 150 kg N ha^{-1} + 70 P2O5 kg ha^{-1} and 150 kg N ha^{-1} + 105 P2O5 kg ha^{-1} treatments were dominated. This indicates that the net benefit was decreased as the total cost that varies increased beyond non dominated fertilizer treatments application. The net benefit curve also clarifies the reasoning behind the calculation of marginal rates of return, which compare the increments in costs and benefits between such pairs of treatments. As indicated in the net benefit curve the net

Table 3: Economic analysis due to the application of N and P fertilizer levels seed yield of Nafis onion grown at Kulumsa in 2017/2018.

N and P_2O_5 rate (kg ha^{-1})	Average seed Yield (kg ha^{-1})	Adjusted seed yield (kg ha^{-1})	Gross Field Benefit (ETB ha^{-1})	Total cost (ETB ha^{-1})	Net benefit (ETB ha^{-1})
0 x 0	952.01	856.81	282747	61280	221467
0 x 35	1093.55	984.19	324783	61843	262940
0 x 70	1254.11	1128.69	372468	62405	310063
0 x 105	1236.09	1112.48	367119	62968	304151
50 x 0	1053.32	947.99	312837	62005	250832
50 x 35	1196.56	1076.9	355377	62568	292809
50 x 70	1412.97	1271.67	419651	63530	356121
50 x 105	1660.67	1494.6	493218	63693	429525
100 x 0	1126.72	1014.05	334637	62730	271907
100 x 35	1394.38	1254.94	414130	63293	350837
100 x 70	1861.05	1674.95	552734	63855	488879
100 x 105	1740.6	1566.54	516958	64418	452540
150 x 0	1162.68	1046.41	345315	64455	280860
150 x 35	1591.41	1432.27	472649	64018	408631
150 x 70	1700.45	1530.41	505035	64580	440455
150 x 105	1671.67	1504.5	496485	65143	431342

The price of urea and TSP fertilizer was 11.50 and 12.50 ETB kg^{-1} respectively and selling price of onion seed was 330 ETB kg^{-1}

profit start from lowest 221467.3$ and end up or reaches 488878.5$ from the treatments (0 kg N ha^{-1} + P2O5 kg ha^{-1}) (Control), 100 kg N ha^{-1} +70 P2O5 kg ha^{-1}, respectively. Therefore, the net benefit reduced as the cost increased (Figure 3).

Marginal rate of return (MRR %)

The percentage marginal rate of return (%MRR) between any pair of dominant treatments denotes the return per unit of investment in fertilizer expressed as a percentage. Passing from the first treatment that had the lowest costs that vary to the end treatment which had the highest cost that vary, the marginal rate of return obtained was above the minimum acceptable marginal rate of return. The best recommendation for treatments not subjected the highest marginal rate of return, rather based on the minimum acceptable marginal rate of return and the treatment with the highest net benefit together with an acceptable MRR becomes the tentative recommendation (CIMMYT, 1988). In this study, 100% was considered as minimum acceptable rate of return for farmer's recommendation. For instance for every 1.00 Birr invested at application of N and P fertilizer, farmers can expect to recover the 1.00 Birr, and obtain an additional 366.38 Birr ha^{-1} combined application of 100 N and 70 kg P2O5 ha^{-1} and also the second alternative recommendation with values of Marginal return ETB 279.10 profit per unit investment for onion seed production was obtained from application of 50 kg N with 105 P2O5 kg ha^{-1} (Table 4). This recommendation is supported by CIMMYT (1988) which stated that farmers should be willing to change from one treatment to another if the marginal rate of return of that change is greater than the minimum acceptable rate of return [33].

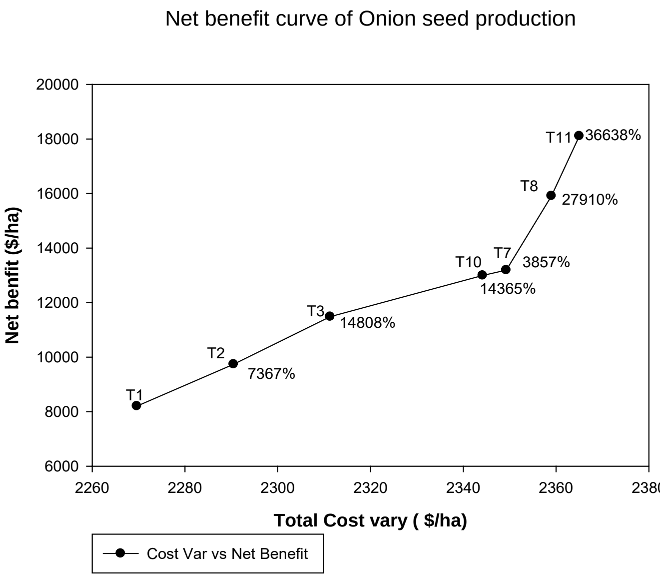

Figure 3: Net benefit curve of onion seed production as influenced by N and P fertilizers at Arsi area.

Conclusion

Onion is one of the most important vegetable crops commercially grown both by large and small scale farmers in Ethiopia. It is a high value and high income generating vegetable crops for most farmers in Ethiopia, which is widely produced in small scales and by commercial growers and considerably important in the daily meal of Ethiopians. Onion is one of the most important income generation crops both cultivated under rained and irrigation in Arsi Zone South Eastern Ethiopia.

The enhancement of onion production and productivity can be constrained different growth factors. Thus, the use of appropriate agronomic management has an undoubted contribution to increased crop yields. There are a number of constraints that cause low productivity of onion seed production in Ethiopia. The low yield of onion seed in the country is due to low fertility of soil, inappropriate fertilizer rate, lack of improved varieties, and poor management practices. Among these constraints, inappropriate use of mineral fertilizer was one of the most important management factors in Arsi Zone.

A field experiment was conducted under irrigation condition during the off-season of October 2017 to March 2018 at Kulumsa, South-Easter Ethiopia. The treatments were combinations of four levels of N (0, 50, 100, and 150 kg ha^{-1}) from urea (46-0-0) and four levels of P2O5 (0, 35, 70, and 105 kg ha^{-1}) from TSP (0-46-0). The treatment combinations were arranged factorial in randomized complete block design (RCBD) with three replications.

The results of the study revealed that most of the onion growth

Table 4: Dominance analysis and marginal rate of return of the application of N and P fertilizer rates on onion seed production at Arsi in 2017/2018.

N and P_2O_5 rate (kg ha^{-1})	Total cost (ETB ha^{-1})	Net benefit (ETB ha^{-1})	Dominance	Marginal Return	Marginal rate of return (%)	Benefit cost ratio
0 x 0	61280	221467		-	-	-
0 x 35	61843	262940		73.67	7367	4.25
50 x 0	62005	250832	Dominated			
0 x 70	62405	310063		148.08	14808	4.97
50 x 35	62568	292809	Dominated			
100 x 0	62730	271907	Dominated			
0 x 105	62968	304151	Dominated			
100 x 35	63293	350837		143.65	14365	5.54
50 x 70	63430	356121		38.57	3857	5.61
50 x 105	63693	429525		279.1	27910	6.74
100 x 70	63855	488879		366.38	36638	7.66
150 x 35	64018	408631	Dominated			
100 x 105	64418	452540	Dominated			
150 x 0	64455	280860	Dominated			
150 x 70	64580	440455	Dominated			
150 x 105	65143	431342	Dominated			

parameters considered were significantly affected by the N and P treatments. Days to maturity were significantly affected by level of N and P fertilizers. Early bolting, flowering and maturity days were recorded with the application of fertilizer with 0 kg N with 70 and105 kg P2O5 ha^{-1}. On the other hand, delay in days to maturity was recorded from control and at highest N fertilizer rates. Other growth parameters such as flower stalk height were also significantly increased with application of N and P fertilizers; the highest results were obtained from fertilizer rate of 100 kg N with 70 kg P2O5 ha^{-1}.

As conclusions, N application resulted in pronounced effect on vegetative characters of onion than the phosphorus effect in the combined application. As nitrogen rates increased, onion seed maturity delayed. The moderate amount of the experimental soil may compromise the applied P fertilizer on the vegetative characters owing to its little inherent contributions for vegetative growth.

Generally, nitrogen and phosphorus fertilizer application would be preferred for onion seed production. The application of nitrogen at 100 kg N ha^{-1} and phosphorus at 70 kg P2O5 ha^{-1} appeared to be a promising combination which gave highest benefit cost ratio (marginal rate of return) which could be recommended for high onion seed yield with the required quality in the study area. However, in order to give conclusive recommendation for the study area, similar field and economic feasibility studies need to be carried out at least for one more cropping season.

Conflict of Interests

The authors have not declared any conflict of interests.

Acknowledgements

Ethiopian Institute of Agricultural Research is appreciated for financial and technical and material support

References

1. Abas A, Sahar I El, Alia M, Osman E, Mohamed A, Nourai H, et al. (2015) Effect of nitrogen fertilization and bulb spacing on saggai red onion seed production in Berber area, River Nile State, Sudan Sudanese. Journal of Agricultural Sciences 2: 35-43.
2. Abayneh Esayas, Demeke Tafase, Gebeyehu Belay, Kebede Agazegn (2003) Soil of Kulumsa Agricultural Research Center. National Soil Research Center (NSRC), Soil survey and land evaluation, Technical Paper No 76.
3. Abdissa Yohannes, Tekalign Tadesse, Pant L M (2011) Growth, bulb yield and quality of onion *(Allium cepaL.)* as influenced by nitrogen and phosphorus fertilization on vertisol. Growth attributes biomass production and bulb yield. African Journal of Agricultural Research 6: 3252-3258.
4. Ahmed IH, Abdulla AA (1984) Nitrogen and phosphorous fertilization in relation to seed production in onion *(Allium cepa L.)*. Acta Horticulture 48: 119-125.
5. Al-Fraihat AH (2009) Effect of different nitrogen and sulphur fertilizer levels on growth, yield and quality of onion *(Allium cepa L.)*. Jordan Journal of Agricultural Science 5: 155-166.
6. Ali MK, Alam MF, Alam MN, Islam MS, Khandaker SMAT, et al. (2007) Effect of nitrogen and potassium level on yield and quality seed production of onion. Journal Applied Science Research 3: 1889-1899.
7. Aminpour R, Mortzavi Bak A (2004) Effect of planting date and intra-row spacing on seed yield and germination of onion (Allium cepa L. cv.Texas Early Grano 502. Pajouhesh and Sazandegi 62: 64-69.
8. Asfaw Zeleke, Eshetu Derso (2015) Production and management of major vegetable crops in Ethiopia. pp: 32-51. Ethiopian Institute of Agricultural Research. Addis Abeba, Ethiopia.
9. Ashenafi Woldeselassie, Helen Teshome, Tibebu Simon (2014) Influence of bulb treatment and spacing patterns on yield and quality of onion *(Allium cepa var. Cepa)* seed at Humbo Larena, Southern Ethiopia. Journal of Biology Agriculture and Healthcare 4: 111-119.
10. Brewster JL (1994) Onions and other vegetable Alliums. CAB publishing UK. 321p.
11. Chadha ML, Altoveros EC, Womdim RN, Mndiga H (1997) Variety evaluation and seed production of vegetable crops. AVRDC Africa Regional Program, Arusha, and Tanzania 65: 56-110.
12. Dawit Alemu, Abera Deressa, Lemma Dessalegn, Chimdo Anchala (2004) Domestic vegetable seed production and marketing. Research report Nazareth Ethiopia 29p.
13. Debashis Manna, Maity TK, Basu AK (2017) Response of Quality Seed Production of Onion (Allium Cepa L.) to Different Levels of Nitrogen and Potassium Application. Research. Journal of Chemistry, Environmental Science 5: 38-45.
14. Fekadu Mariamel, Dandena Gelmasa (2006) Review of the status of vegetable crops production and marketing in Ethiopia. Uganda Journals of Agricultural Science 12: 26-30.
15. Getachew Amare (2014) Effect of plant spacing and NP fertilizer levels on growth, seed yield and seed quality of onion (Allium Cepa Var Cepa) in MSc. Thesis Shewa robit, Northern Ethiopia 66p.
16. Griffiths G, Trueman L, Crowther T, Thomas B, Smith B, et al. (2002) Onions-a global benefit to health. Phytotherapy Research 16: 603-615.
17. Grubben JH, Denton DA (2004) Plant resources of tropical Africa. PROTA Foundation, Wageningen; Back huys, Leiden; CTA, Wageningen.
18. Gupta RP, Sharma VP (2000) Effect of different spacing and levels of nitrogen for production of export quality onion bulbs planted on raised bed. News Letter National Horticultural Research and Development Foundation 20: 13-16.
19. Jilani MS, Ahmed P, Waseem K, Kiran M (2010) Effect of Plant Spacing on Growth and Yield of Two Varities of Onion (Allium Cepa L.) Under The Agro-Climatic Condition of D. I. Khan. Pakistan Journal of Science 62 (1).
20. Karim RM, Ahmed F, Hoque MM (1999) Effect of bulb size and spacing on the bulb yield of onion. Bangladesh Journal of Agriculture Review 24: 609-613.
21. Kiros Asgele, Kebede Woldetsadik, Fikreyohannes Gedamu (2018) Effect of inorganic NP fertilizers and vermicompost on growth, seed yield and yield components of onion *(Allium cepa L.)* at Maitsebri, Northern Ethiopia 10: 89-96.
22. Kulkarni BS, Patil SM, Ramchandra VA (2014) Growth trends in the area, production, and export of onion from India-An economic analysis. International Journal 5: 159-163.
23. Lemma Dessalegn (1998) Seed production guideline for tomatoes, onion and hot pepper. Institute of Agricultural Research (IAR) 22p.
24. Lemma Dessalegne, Shemelis Allilu (2003) Research Experiences in Onion production. EARO.52p.
25. Google Scholar
26. Marschner H (1995) Mineral Nutrition and Yield Response. Mineral Nutrition of Higher Plants, (2ndedn), Academic press. London UK 184-200.
27. Meena PM, Umrao VK, Kumar A, Kumar R (2007) Effect of nitrogen doses on growth and yield of onion *(Allium cepa L.)* cv.'Nasir red'. Agricultural Science Digest 27: 144-145.
28. Morsy MG, Marey RA, Karam SS, Abo-Dahab AMA (2012) Productivity and Storability of onion as influenced by the different levels of NPK fertilization. Journal of Agricultural Research Kafer El-Sheikh University 38: 171-186.
29. Muhammad B (1999) Effect of Nitrogen and Phosphorus on Seed Production of Three Onion *(Allium cepa L.)* Cultivars. Pakistan Journal of Biological Sciences 2: 752-754.
30. Sidhu AS, Kumar JS, Chadha ML (1996) Seed production potential of different Genotypes of onion. Onion News Letter for the Tropics 7: 38-41.
31. Sorensen JN, Grevsen K (2010) Sprouting in bulb onions *(Allium cepa L.)* as influenced by nitrogen and water stress. Journal of Horticultural Sciences Biotechnology 76: 501-506.
32. Google Scholar
33. Tamrat Tesem (2006) Effect of nitrogen and phospherous application on seed yield and nutrient uptake of onion *(Allium cepa var. cepa)*. MSc. Thesis, Haramaya Universty Ethiopia 81p.
34. Teshome Ashagrie, Derbew Belew, Sentayehu Alamerew, Yehenew Getacew

(2014) Effect of planting and Mother Bulb size on onion seed yield and quality at Kobo Woreda, Northern Ethiopia. International Journal of Agricultural Research 1-11.

35. Zohary D, Hopf M (2000) Domestication of plants in the old world 3rd ed. Oxford University press 197-198.