E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2018; 1(2): 38-41
Received: 11-06-2018
Accepted: 15-08-2018

Birhanu Gebeyehu
Bahir Dar, Amhara Region in Northern Ethiopia

Corresponding Author:
Birhanu Gebeyehu
Bahir Dar, Amhara Region in Northern Ethiopia

Effect of nitrogen and phosphorous application on seed yield and nutrient uptake of onion (*Allium cepa* L.)

Birhanu Gebeyehu

Abstract
Onion is an herbaceous biennial monocot cultivated as an annual. The higher seed yield in onion cultivars was due to the higher number of seed stalks per plant and to a wider umbel diameter which were influenced by application of N and P fertilizers. The number of flower opening on each day was influenced by the number of hours of sunshine and concentration of phosphorous and nitrogen. N and P treatments tended to lower bolting percentages. The yield of seed per plant increased as the nitrogen in the nutrient solution increased where seed stalks were produced. The effect of early dressings of N on crops grown under conditions when nights are becoming cooler is shown to allow the plants to reach a 'bolting inducible' stage early in the growing season. There is maximum response of onions to P fertilization in the range 0-52 kg ha-1. Plant roots take up nitrogen from the soil solution principally as nitrates (NO3-) and NH4+ ions. Nitrate is the preferred form of N for uptake by most plants, and it is usually the most abundant form that can be taken up in well-aerated soils. Nitrogen fertilizer application improves phosphorus uptake from the soil. Onion absorb phosphorous in the form of H^2PO^4- and H^2PO^4-. Too much phosphorus level affects plant growth by suppressing the uptake of iron, potassium and Zink. The availability of inorganic phosphorus is largely determined by soil Ph. Leaching losses of nitrate are growing crop cover to absorb the nitrates as rapidly as they are produced. Soil Ph drastically influences the reaction of phosphorus with the different ions and minerals. To increase the yield of onion seed the application of N and P fertilizer should be determined.

Keywords: nitrogen, phosphorus, onion, yield

1. Introduction

1.1 Background and Justification

In recent estimations there are about 750 species in the genus Allium, among which onion, Japanese bunching onion, leeks and garlic are the most important edible Allium crops (Rabinowitch and Currah, 2002). Onion (*Allium cepa*) is believed to have originated in Afghanistan, the area of Tajikistan and Uzbekistan, western Tien Shan and India while western Asia and the areas around the Mediterranean Sea are secondary centers of development. Onion is an herbaceous biennial monocot cultivated as an annual. Onion is used primarily as flavoring agents and its distinctive pungency which is due to the presence of a volatile oil (allyl propyl disulphide). The mature bulb contains some starch, appreciable quantities of sugars, some protein, and vitamins A, B, and C (Decoteau, 2000) [8].

Allium and its close relatives are recognized as distinct family the Alliaceae. The estimated total area under onion production in Ethiopia is about 13,000 hectares from which 163,800 tones were produced in 2004 E.C with average yield of about 12.9 t / ha. Onion seeds are well known to be highly feo 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 and of high germination and vigor (Currah and Proctor, 2004) [7]. Gigging and selection to include mature bulb morphology and is especially important for basic seed production. The first, as an annual method takes less than a year and doesn't involve lifting and storing the bulbs (Brewster, 2001 George, 2003) [4]. Enormous differences in average seed yields are observed depending on genotype, locality, season, soil type and method of seed production (Jones, 2002; Brewster, 2003) [14, 4]. The expensive bulb to seed method is commonly used for seed production. Bulbs of medium size classes (4-5 cm diameter) are recommended for seed production (Yohannes, 2007).

The seed supply from the domestic production is not as required and vegetable growers depend mainly on imported seeds that have mostly poor germination and uniformity and susceptible to diseases (Lemma, 2005) [5]. There are various production constraints of onion seed among which is lack of appropriate amount of fertilizers under local condition.

Fertilizer practices for the onion seed crop vary widely. Fertilizer recommendations, derived from experimental work by Nandpuri *et al.* (2006) [21] are to apply 62 kg P/ha and 50 kg K/ha before planting and 125 kg N/ha split into two doses, half to be given 2 weeks after planting the mother bulbs, when the shoots are appearing, and half 45-60 days later. Experiments conducted on 26 multilevel N-fertilizer trials in the Netherlands showed that application rates ranging from 72 to 110 kg/ha could be applied as two or three split dressings, but the work did not change existing recommendation of a fixed rate of 100-120 kg N/ha (Rabinowitch and Currah, 2002).

Phosphorus is an essential component of deoxyribonucleic acid (DNA), the seat of genetic inheritance, and of ribonucleic acid (RNA), which directs protein synthesis in both plants and animals. Phospholipids, which play critical roles in cellular membranes, are another class of universally important phosphorus-containing compounds. For most plant species, the total phosphorus content of healthy leaf tissue is not high, usually comprising only 0.2 and 0.4% of the dry matter (Brady and Weil, 2002) [3]. Root growth, particularly development of lateral roots and fibrous rootlets, is encouraged by phosphorus.

In cereal crops, good phosphorus nutrition strengthens structural tissues such as those found in straw or stalks, thus helping to prevent lodging (falling over). Improvement of crop quality, especially in forages and vegetables, is another benefit attributed to this nutrient (Brady and Weil, 2002) [3]. Then the objective of this paper is to review the effects of N and P application on yield, yield component and nutrient up take in onion.

2. Literature Review

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, 2004). The study of Ogawa in (2006) [23] he indicated that plants with the longest seed stalks produced the highest seed yield and seed weight was considered an estimation of vigor. This indicated that this character could be a good index for seed yield estimation in onion. Cultivars with bigger bulbs produced wider inflorescences and greater seed yield. The variation in yield among the cultivars was caused by the large difference in number of umbels per plant and number of productive florets per umbel (Prats *et al.*, 2007) [26].

Sidhu *et al.* (2006) [28] reported that the higher seed yield in some onion cultivars was due to the higher number of seed stalks per plant and to a wider umbel diameter and, hence, the capacity of flowering of the plants was expressed by the umbel size.

According to Ahmed, 2008 [1] He reported that fertilizer N, P and K affect bolting and the yield and quality of onion seed. N and P treatments tended to lower bolting percentages, while application of K tended to encourage bolting (7-23% increases) of onion cultivar Nasi grown on heavy clay soil in Sudan. However, other work by Hassan (2005), which included irrigation timing and nitrogen as the factors studied, indicate that both bolting and doubling were increased at the higher N level.

On the contrary, effect of N nutrition on the number of inflorescences per plant and their development did not show any significant response on bolting but under low temperature induction, floral bud formation was enhanced by low N levels as compared with high N regime (Rabinowitch and Brewster, 2009) [27]. In Maryland, using yellow Bermuda 986' in green house, showed that the plant which were given little or no nitrogen were small and seldom divided to form more than one seed-stalk, but they bolted uniformly. Plants on high nitrogen, however, were strongly vegetative and frequently bulbed instead of bolting. He further indicated that the yield of seed per plant increased as the nitrogen in the nutrient solution increased where seed stalks were produced. According to Ahmed (2008) [1] fertilizer N, P and K affect the yield and quality of onion seed product. How other studies showed that higher level of nitrogen increased seed yield but at the expense of seed quality. High K levels during bulb production were carried over to the second year and also enhanced seed quality. Mohamedali and Nourai (2004) [20] stated that the application of nitrogen fertilizer appreciably increased seed yield per onion and umbel number per plant in Sudan. This increment in seed yield was a result of reduced flower abortion showed in their experiments conducted over two successive seasons showed that nitrogen application had phosphorus significantly increased plant height, flower stalk thickness and seed yield. But fertilization in the absence of nitrogen had no significant effect on seed yield. However, a highly significant increase in seed yield was obtained when phosphorus was used in combination with nitrogen. Nitrogen and phosphorus separately or in combination proved to have no effect on the number of branches or flower stalks produced per plant. Evidence points that N starvation during early stage of growth encourages bolting in the first growing season. The effect of early dressings of N on crops grown under conditions when nights are becoming cooler is shown to allow the plants to reach a ‘bolting inducible’ stage early in the growing season. (Currah and Proctor, 1990). Adequate nitrogen fertilization is essential for maximum yields. In Italy, N fertilizer levels from 0 to 150 kg ha-1 in 30 kg ha-1 increments showed that seed yield increased linearly from830 to 1100 kg ha-1 with increasing N (Cuocolo and Berbieri, 2007) [6]. Fertilizer trial on onion in a semiarid tropical soil of Nigeria showed that N and P and their interaction increased number of umbels per original bulb, seed weight per umbel and seed yield. At 50 kg P ha-1, the application of 50 or 100 kg N ha-1 gave significantly higher seed yield than other N and P rate combinations tested (Nwadukwe and Chude, 1995) [22]. Application of both P and K together with N, didn't affect the number of inflorescences formed. However, applications of either P or K significantly enhance bolting (Rabinowitch and Brewster, 2008). Shemelis (2000) in his study of flower and seed production potential of onions in Melkasa, found that Adama Red was bolted within 24.7 days. Nitrogen has physiological functions in plant which increase the plumpness and succulence of crops thereby encourages the vegetative growth rather than reproductive structure development (Staurt and Griffin, 2006). Furthermore, the relatively cool climatic condition of the experimental site compared with Melkassa seemed to have contributed for delaying the overall growth of the crop (Nwadukwe, 2005) [22].

The nutrients absorbed from the soil could have diverted and sink into vegetative parts for photosynthesis and resulted in plants will end up with a luxurious foliage growth. The duration of flowering was expected to be affected by the growing condition (Globerson *et al.*, 2008) [13].

Patil *et al.* (2003) [25] recorded days to flowering ranging from 82.5-88.3 days under different moisture regimes. The effect on the reduction of sugar concentration in the leaves during the early ripening stage and inhibition of the translocation of

assimilated products (Marschner, 2005). Sidhu *et al.* (2008) [28] found stalk heights for other cultivar of onion in the range of 76-93 cm. This increment of height applied N in part could be due to major factor of N contributing to the higher rates of vegetative growth and stem elongation when high doses of nitrogen fertilizers are applied to the plants. The environment and the size of the mother plant also have a modifying effect on the flower, stalk height and diameter (Jones, 2002) [14]. On the other hand, phosphorus fertilizer application didn't show significant difference both on flower stalk height and diameter. This might be due to phosphorus being not available to the plant at the rate sufficient for increasing the flower stalk height and diameter 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) [3].

Cuocolo and Berbieri (2006) reported that increasing application rates of N fertilizer increased the seed yield per plant. The effect of phosphorus application in increasing bulb yield and its characteristics could be explained through the role of phosphorus (Singh *et al*, 2000).

Shaheen *et al*. (2007), reported that the highest application of phosphorus (92kg/ha phosphorus) fertilizer had a major effect on the productivity of onion plant, hence increased total bulb yield and its components. Application of phosphorus level positively increase and significantly affect bulb length, bulb diameter, average bulb weight, bulb dry matter content, marketable yield and total bulb yield.

The highest rates of Phosphorus 115 and 147 $kg \cdot ha^{-1}$ gives better growth and yield (Singh and Singh, 2000).Growers on the southeast Georgia use a considerable amount of Phosphorus fertilizer as high as 89 $kg.ha^{-1}$ based on a standard fertilizer program. Significant amounts of Phosphorus fertilizer, particularly $(NH_4)_2H_2PO_4$, usually appear greener with larger tops. High Phosphorus fertilizer may be warranted when onion tops are damaged such as during hailstorms, these onions may also benefit from high Phosphorus fertilizer in which large green tops are important (Boyhan *et al.*,2001).

In addition, phosphorus has an indispensable role in energy metabolism, high energy of hydrolysis of phosphate and various organic phosphate bonds being used to induce chemical reaction (Shaheen*et a*,*l*, 2007).

There is maximum response of onions to Phosphorus fertilization in the range 0-52 kg ha-1. Depending on yield levels, Phosphorus uptake rates in onion are estimated to be about 15-30 kg ha-1. Depending on soil Phosphorus status, cultivar and plant density, phosphorus application rates of up to 200 kg ha-1 were found to maximize onion yields and bulb weights (Vachhani, Patel, 2005) and reduce storage loss of bulbs (Singh *et al*., 2000). Increased Phosphorus levels are also known to improve bulb size and the number of marketable bulbs in onion. Regardless of the Phosphorus status of the soil, placement of Phosphorus fertilizers in the soil near to the plant would be the most effective method of Phosphorus supply to onion plants (Brewster, 2003)

3. Summary and Conclusions

Onion is grouped under the family of alliaceae. 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 is the improper application of N and P application for the true to type and of high germination and vigor. Fertilizer practices for the onion seed crop vary widely. There are two onion seed production methods, the seed-to-seed and bulb-to-seed methods. A good supply of nitrogen stimulates root growth and development as well as the uptake of other nutrients. Plants responds quickly to increased availability of nitrogen, their leaves turning deep green in color. Root growth, particularly development of lateral roots and fibrous rootlets, is encouraged by phosphorus. Fertilizer N, P and K affect bolting and the yield and quality of onion seed. Plants on high nitrogen, however, were strongly vegetative and frequently bulbed instead of bolting. Nitrogen and phosphorus separately or in combination proved to have no effect on the number of branches or flower stalks produced per plant. High bolting levels in plant raised from seed have also been reported to result from using low level of N. The nutrients absorbed from the soil could have diverted and sink into vegetative parts for photosynthesis and resulted in plants will end up with a luxurious foliage growth. The delay in maturity due to N fertilizer application could be possibly due to the fact that this element affects the supply of carbohydrate during the critical period of reproductive phase. Increasing application rates of N fertilizer increased the seed yield per plant. Plant roots take up nitrogen from the soil solution principally as nitrates (NO3-) and NH4+ions.

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