RESEARCH ARTICLE

Influence of nitrogen fertilizer rates and plant spacing on the yield components and quality of shallot (*Allium ascalonium* L.) in Mulo district, Ethiopia

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One of the major alliaceous crops grown in many tropical nations is the shallot (*Allium ascalonium* L.). In Ethiopia, it is a significant horticultural product that is used to flavor the regional stew known as "wot" and provides farmers with revenue. However, the productivity of shallot is low at study area due to various limiting factors such as low soil fertility, plant population and lack of improved agronomic practices. A field experiment was conducted to investigate the effect of intra-row spacing and nitrogen fertilizer levels on growth, yield and quality of shallot at Mulo district, Oromia Regional state, Ethiopia during 2021/22 off season. The treatments consisted of four intra-row spacing (5, 10, 15 and 20) cm and four levels of nitrogen fertilizer (0, 50, 100 and 150) kgNha^{-1} tested in a randomized complete block design with three replications.

Key Words: *Agronomic practices; Intra-row spacing; Nitrogen fertilizer; Quality*

INTRODUCTION

The shallot remains unique of the essential crops that belong to the Alliaceae family which includes other plants such as chives, leeks, garlic and onions. It was believed that the common onion is originated from central Asia and the shallot is native to Asia Minor. It is very similar to common onion; unlike the common onion, which has a large single bulb, it produces clusters of several bulb splits (2 to 20 bulb lets). Farmers prefer shallots for their better tolerance to disease, shorter growth cycle and drought stresses and longer storage life than the common onion and for their distinct flavor that persists after cooking [1-4].

MATERIALS AND METHODS

Description of the study site: The experiment was conducted at Mulo district, North Shewa, Oromia, Ethiopia, during the 2021/22 off-season cropping. Mulo is 31 km from the north of Addis Ababa and is geographically located at about 9° 04' 60.0" N latitude and 38° 13' 00.0" E longitude at an altitude of 2315 meters above sea level. The minimum temperature of 6-10°C and maximum temperature of 18-23°C. The mean annual temperature is 15.36°C, with a mean minimum of 8°C in December and a maximum of 22.9°C in February and May. The soil of the experimental site was characterized by well-drained clay loam with sand (21% sand, loam 21%, and 58% clay) with a pH of 6 [5].

Description of the experimental materials: Improved shallot variety called 'DZSHT-005 obtained from Debre Zeit Agricultural Research Center (DZARC) was used as planting material for the experiment. 'DASHT-005 ' was released by DZARC during 2019. The variety is high yielding and well adapted to the agro-ecology of the study area. Urea was applied as a source of nitrogen and which was bought from Mulo agricultural bureau.

RESULTS AND DISCUSSION

Yield components and bulb yield of shallot

Bulb length: The interaction of nitrogen and intra-row spacing had a highly significant ($p<0.001$) on bulb length. The bulb length of shallot increased consistently as the rate of nitrogen application increased, the highest value 5.41 cm obtained from the application of nitrogen at 150 kgha^{-1} and intra row spacing of 20 cm (Table 1). However, which was statistical similar 15 cm combination with 150 kgNha^{-1}. The growth of a wider bulb length in shallot at higher nitrogen levels could be attributed to the availability of adequate growth resources due to less competition, which allows the bulb to collect more includes available for storage, resulting in a longer bulb. Furthermore, larger bulb length in shallot with high nitrogen application rate and wider space may be linked to nitrogen promoting nature in cell elongation, above ground vegetative growth and synthesis of more chlorophyll to impart dark green color of leaves, which may be linked to an increase in dry matter production and translocation to the bulb. However, the growth of a shorter bulb length in shallot at nil nitrogen levels and closer intra row spacing could be attributed to the availability of insufficient growth resources due to high competition, which prevents the bulb from collecting as many nutrients for photosynthetic, storage and above ground vegetative growth, resulting in a shorter bulb length. Hordofa et al., reported that increasing the rate of nitrogen significantly increased bulb diameter, indicating that nitrogen promotes growth of bulbs. The lowest value 2.95 cm was recorded bulb length at nil application of nitrogen and intra row spacing of 5 cm (Table 1) [6].

TABLE 1
Interaction effects of nitrogen fertilizer and intra row spacing on shallot parameter

Treatment	Yield components						
S	N	BL	BD	ABW	BFW	BDW	BDM (%)
5	0	2.95^{i}	3.07^{k}	24.85^{m}	26.00^{i}	5.70^{f}	5.10^{i}

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5	50	3.12^{h}	3.19^{j}	36.16^{k}	36.00^{h}	6.16^{ef}	6.76^{h}
5	100	3.38^{g}	3.42^{i}	46.13^{i}	48.00^{g}	6.25^{ef}	7.48g^{h}
5	150	3.54^{f}	3.56^{h}	51.21^{g}	52.67^{f}	6.30^{ef}	9.32^{cd}
10	0	3.03^{hi}	3.13^{jk}	30.95^{l}	28.00^{i}	5.71^{f}	5.14^{i}
10	50	3.61^{f}	3.23^{j}	48.83^{h}	48.00^{g}	6.16^{ef}	7.54^{fgh}
10	100	4.01^{e}	4.58^{e}	64.86^{e}	71.67^{e}	6.26^{ef}	8.89^{de}
10	150	5.17^{b}	4.73^{d}	67.85^{c}	113.33^{bc}	8.48c	10.62^{ab}
15	0	3.11^{h}	3.36^{i}	34.95^{k}	33.67^{h}	5.78^{f}	5.25^{i}
15	50	3.540^{f}	3.60^{gh}	52.01^{g}	55.00^{f}	6.65^{e}	7.95^{fg}
15	100	4.83^{c}	4.88^{c}	66.21^{de}	103.00^{d}	9.88^{b}	9.55^{cd}
15	150	5.40^{a}	5.45^{a}	72.00^{a}	118.67^{a}	11.05^{a}	10.46^{ab}
20	0	3.12^{h}	3.68^{g}	38.37^{j}	36.00^{h}	5.92^{ef}	6.98^{h}
20	50	3.51^{f}	4.06^{f}	56.11^{f}	69.33^{e}	7.57^{d}	8.31^{ef}
20	100	4.67^{d}	5.22^{b}	66.56^{cd}	110.33^{c}	10.58^{a}	9.85^{bc}
20	150	5.41^{a}	5.45^{a}	69.86^{b}	117.67^{ab}	11.08^{a}	10.73^{a}
CV (%)		2	1.5	1.8	4.2	6.5	6.1
LSD (5%)		0.13	0.1	1.51	4.65	0.81	0.82

Note: LSD: Least Significant Difference; CV: Coefficient of Variation; HI: Harvest Index; BL: Bulb Length; BD: Bulb Diameter; ABW: Average Bulb Weight; BDW: Bulb Dry Weight; BDM: Bulb Dry Matter

Quality parameter

Bulb dry weight: The interaction effect of nitrogen rate as well as intra row spacing was highly significant ($p<0.01$) influenced on bulb dry weight at oven results of shallot 70°C with 48 hr. The combination of nitrogen application rate at 150 kgha^{-1} and intra row spacing of 15 cm produced the highest bulb dry weight 17.90 g. The application of nitrogen at a rate of 0 kgha^{-1} and intra row spacing of 5 cm, in contrast, resulted in the lowest (15.42 g) bulb dry weight. The improvements in bulb dry weight could be attributed to an increased photosynthetic area in response to nitrogen fertilization and intra row spacing that may have enhanced assimilate production and partitioning to the bulbs that led to increased bulb dry weight. Thus an adequate supply of nutrients to plants is associated with vigorous vegetative growth that results in higher productivity of crops. Dereje et al., also observed that shallot bulbs planted at wider intra-row spacing produced greater bulb dry weight per plant than that planted at closer intra-row spacing [7].

Total soluble solid: The effect of nitrogen fertilizer as well as that of intra-row spacing highly significant ($p<0.001$) influenced on the total soluble solid. The highest total soluble solid value (14.15%) was recorded at the application of nitrogen fertilizer at the rate of 100 and 150 kgNha^{-1} with intra-row spacing of 5 cm. The increasing rate of nitrogen fertilizer application significantly increased total soluble solids, but the parameter consistently decreased across the increasing intra-row spacing. On the other hand, the smallest total soluble solids were recorded for shallot plants grown at the nil rate of nitrogen application and planted at the intra-row spacing of 20 cm and 15 cm, which were recorded at 11.29 and 11.88% respectively. The wider intra-row spacing also resulted in larger shallot bulbs which get its soluble solids diluted due to higher volume and more water content, as a results, could be smaller. Tekle showed that at the maximum total soluble solid was recorded for higher nitrogen rates and narrow intra-row spacing [8].

On other hand, the application of nil nitrogen fertilizer and intra row spacing of 5 cm results in weight losses of 1.67 and 2.13 g, respectively, at the difference between 3rd and 4th then 4th and 5th weeks storage assessment periods. The lowest bulb weight loss at nil nitrogen fertilizer application rate and intra row spacing could be due to the development of smaller bulbs with lower respiration rates, as resulting, lowest bulb weight. Tekalign et al., also reported high onion bulb weight losses as nitrogen application rate increased as well as the results indicate that storage after 15 days resulted in an unacceptable level of bulb weight loss [9].

Medium bulb size (25.1 g-44.54 g): The nil application of nitrogen fertilizer application and intra row spacing of 5 cm results in weight losses in the differences between the third with fourth and fourth with fifth weeks in which about 2.2 and 2.3 g results, respectively. The lowest bulb weight loss at nil nitrogen fertilizer application rate and intra row spacing could be due to the development of smaller bulbs with lower respiration rates, as resulting, lower respiration rates of smaller bulb size among the medium bulb size. Tekalign et al. also reported significant onion bulb weight losses as the rate of nitrogen application fertilizer increased.

However, the lower with application of nil nitrogen fertilizer and intra row spacing of 5 cm at the 3rd, 4th and 5th weeks under storage assessment periods in which weight losses he differences between 3rd with 4th and 4th with 5th about 2.24 and 2.54 g respectively The lowest bulb weight loss at nil nitrogen fertilizer rates and narrower intra row spacing could be due to development of lower bulbs that have lesser rates of respiration. Tekalign et al. also reported high onion bulb weight losses as nitrogen application rate increased.

CONCLUSIONS

Shallot (*Allium ascalonicum* L.) is one of the oldest cultivated crops and widely used around the world for its characteristic essence as a seasoning, condiment, spice, medicinal and agent food. It is a popular vegetable production in Ethiopia. Because Ethiopia has the ability to grow shallot crop all year long with a combination of small rains and bulb irrigation. However, farmers are producing the crop with very low rates of nitrogen fertilizer and without considering spacing especial depend on broadcasting, zero fertilizer and high plan density in study area. Proper nitrogen fertilizer applications and agronomic management have an undeniable contribution to increased crop yield, productivity and high acceptance of the market. As a result, the nitrogen fertilizer application rates and intra-row spacing were two important agronomic practices that influenced the yield and quality of Shallot bulbs. The optimal management of nutrients through fertilization is regarded as an essential component in a farming system, contributing significantly to the aspects of increasing soil fertility, productivity and crop quality. Furthermore, plant population influences interplant competition for growth factors like water, nutrients and sunlight, which influences plant growth and development if proper spacing is not used. As a consequence, both are necessary in shallot production because they affect shallot bulb development, yield, and quality. As a result, the optimal spacing and plant population are those that maximize yield, vegetable quality and farmer profits while minimizing expenses. Because of the impact of intra-row spacing and nitrogen fertilizer level on shallot yield and quality and to identify the appropriate intra-row spacing and nitrogen fertilizer rate that improves yield and quality as population grows.

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CONFLICT OF INTEREST

The author declares that he has no known competing financial interests that could have influenced the research presented in this study.

DATA AVAILABILITY

Available in the manuscript.

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