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Effects of Nitrogen and Intra Row Spacing on Growth and Yield Component of Lettuce (Lactuca Sativa) in Eastern Gojjam Zone, Ethiopia

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Abstract
Lettuce (Lactuca sativa) an annual plant of Asteraceae family is one of the most important vegetables in human diet. It is the most popular salad crop in the world. A research was conducted in Debremarkos University College of Agriculture and Natural Resource, Department of Horticulture field research in the year 2018/19 G.C cropping season under rain fed condition. The aim of the study was to evaluate the effect of Nitrogen and intra –row spacing on growth and yield components of lettuce. The treatment consisted of three rates of nitrogen (0, 75 and 150 kg ha^{-1} of N) and three level plant spacing (40x20cm, 40x25 cm and 40x30cm). The experiment was laid out as a randomized complete block design (RCBD) with a factorial arrangement and replicated three times. The results revealed that the interaction effects of N and spacing were found to be highly significant on plant height, number of leaves per plant, leaf length, leaf width and yield of lettuce. The highest yield of lettuce (8.31ton/ha) was recorded from treatment combination (150 kg N/ha, 25cm). Therefore, lettuce growers can practice supplementing optimum Nitrogen fertilizer with adequate spacing is the most appropriate option for sustainable lettuce production.
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INTRODUCTION

Lettuce (*Lactuca sativa* L.) belongs to family *Asteraceae*. It is the annual leafy crops and occupies the largest production area among salad crops in the world. It is popular for its delicate, crispy texture and slightly bitter taste with milky juice as fresh condition. It is the most popular amongst the salad vegetable crops (Squire *et al*., 1987).

Lettuce an ancient as well as popular vegetable mainly grown in cool season of the year in tropical and temperate regions of the world, widely used as tender leaves and shoots as green (Bose, 1990; Rahman *et al*., 1997). It's the most popular salad crop in the world. Lettuce is an important leafy salad vegetable, rich in vitamins and minerals (FAO, 2009). The composition of lettuce leaves is approximately 94.3% water, 1.2% protein, 0.2% fat, 2.9% carbohydrate (CHO), 0.7% fiber and 0.7% ash. It is rich in vitamin A, C and E and minerals such as Iron, calcium, phosphorus, sodium, magnesium and potassium. It is usually used as salad with tomato, carrot, cucumber or other salad vegetable and often served alone or with dressing (Raymond, 1997).

Lettuce is getting popularity day to day but its production package is not much known to the Ethiopian farmers. It is evident that high air temperature causes high soil temperature, which retards root growth and affects the uptake of water and nutrients and photosynthesis that consequently results in stunted plant growth and mortality (Firoz *et al*., 2000). The major constraints of lettuce production in Ethiopia include poor agronomic practices, low use of inputs (fertilizer), poor planting material, poor diseases and pest management. One of the major factors of low yield lettuce crop is inadequate fertilizer application and poor agronomic practice (Jilani *et al*., 2010).

This vegetable requires a high rate of nutrients for growth and development. Among the major essential nutrients required by the plants for their normal growth, development and yield (Singh, *et al*, 2003) , the role of nitrogen is acceptable as it is a necessary component of protein, nucleic acids, chlorophyll and certain important enzymes (Pervez *et al.,* 2004). While, excessive use of nitrogen negatively affects the quality as well as yield of agricultural crops (Chen *et al.,* 2004). Nitrogen is very essential for leafy vegetable production (Brintha and Seran, 2009).

Population or plant density is one of the most important elements that affect yield and quality of lettuce (Verker and Spitters ;1973;Sankode, 1980). The improper plant spacing may cause either too dense or too sparse population resulting in the reduction of lettuce yield. But optimum plant density ensures the plants to grow uniformly and properly through efficient utilization of moisture, nutrients, light and thus causes to produce maximum yield of lettuce.

Farmers in the study area are aware of the response of lettuce and other related crops to applied nutrients and agronomic practices. So far not enough information is available and not enough researches work has been conducted towards recommending most appropriate dose of nitrogen and intra-row spacing, it is necessary to conduct an experiment in order to make farmers and research workers to take a decision for adequate dose of nitrogen and intra-row spacing of lettuce. Therefore, the study was initiated to find out the outcome of different

levels of nitrogen and intra row spacing on growth and yield components of lettuce.

MATERIALS AND METHODS

Description of the study area

The research was conducted in Debre markos University College of Agriculture and Natural Resource, Department of Horticulture field research in the year 2018/19 G.C cropping season under rain fed condition. The research site is located at $37^0 43^{`}$E longitude, $10^0 25^{`}$latitude and at an altitude of 2400 meters above sea level. The annual average Temperature 13.5^{o}c whiles the maximum and minimum recited temperature being 24^{o}c and 4^0c respectively. Annual average rainfall was 1380 mm. the general climatic condition of Debre Markos in humid characterized by woynadega weather.

Experimental Material

The **Romney** lettuce variety was used for the experiment and seeds were collected from Holeta agricultural research center. Urea [$CO(NH_2)_2$] was used as a source of nitrogen.

Treatments and Experimental Design

The experiment was conducted to find out the effects of nitrogen and plant spacing in lettuce. The experiment consisted of two factors which had three levels of Nitrogen (0kg/ha (control), 75kg/ha, and150kg/ha) and three level plant spacing (20cm, 25cm, and 30cm).

Factor A: Nitrogen (3 levels)

i. N0: 0 kg/ha (Control)
ii. N1: 75 kg/ha
iii. N2: 150 kg/ha

Factor B: Plant spacing (3 levels)

i. S1: 40 cm × 20 cm
ii. S2: 40 cm × 25 cm
iii. S3: 40 cm × 30 cm

There were 9 treatment combinations such as T1(N_0S_1) ,T2(N_0S_2) , T3(N_0S_3), T4(N_1S_1), T5(N_1S_2), T6(N_1S_3), T7(N_2S_1), T8(N_2S_2) and T9(N_2S_3). The experiment was laid out as randomized complete block design (RCBD) in 3 x3 factorial arrangements with 3 replications.

Experimental procedure

The experimental field was ploughed by a tractor. The lay out was done as per the experimental plan. The lettuce crop was sow on lettuce seed bed and transplanting based on the treatment. Nitrogen was applied in two splits (1/2 at the time of planting and another ½ after 30 days of planting). Weeding and other management activities were done at the appropriate time to facilitate vegetative growth of lettuce vegetable uniformly.

Harvesting

Even if they were different harvesting stage to evaluate the yield of lettuce, this study used once harvesting stage which is especially common. To evaluate yield, harvestings was done at 50 days after transplanting.

Data collection and measurements

Data were recorded on the following parameters from the sample plants during the course of experiment. Five plants from the three middle rows were selected from each of the unit plot for the collection of data. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect. The growth and the yield parameter were recorded after 50 days after transplanting.

Growth Parameter

Plant Height

The height of plant was recorded in centimeter (cm) at 50 days after transplanting (DAT) in the experimental plots. The height was measured from the attachment of the ground level up to the tip of the growing point.

Number of leaves per plant

The total number of leaves per plant was counted. Data were recorded as the average of five plants selected at random from the inner rows in the experimental plots at 50 days after transplanting.

Leaf Length

The leaf length was measured by using a meter scale. The measurement was taken from base to tip of the leaf. Average length of leaves was taken from five selected plants from inner rows of each specific plot. Data were recorded at 50 days after transplanting.

Leaf width

Leaf width was recorded as the average of five leaves selected at random from the plant of inner rows of each plot at 50 days after transplanting.

Yield Parameter

Yield

Yield of lettuce per plot was recorded as the whole plant in one harvest within a plot and was expressed in kilogram. Yield included weight leaves at harvesting 50 days after transplanting. Yield per hectare of lettuce was calculated

by converting the weight of plot yield to hectare and was expressed in ton.

Data Analysis

The data subjected to analysis of variance (ANOVA) using the Generalized Linear Model of the SAS statistical package (SAS Inst., Cary, NC, 2002) version 9.1. All pairs of treatment means were compared using the Least Significant Difference (LSD) test at 5% level of significance.

RESULTS AND DISCUSSION

Data on growth and yield parameters were recorded during the course of the study. The results of the study are presented and discussed as follows.

Growth parameter

Plant height

The interaction effect of nitrogen and intra row spacing was highly significant on plant height (Table 1). The lowest plant height of lettuce was recorded under the control treatment (0, 20). The tallest plants were obtained in response to applying the highest rates of nitrogen and the widest rate of intra - row spacing (150 kg N/ha , 30 cm) which was in statistical parity with the height of plants observed in response to in the absence of nitrogen and broad intra row spacing application(0 Kg N/ha,30 cm). The increased plant height observed in response to the increased application rates of the nitrogen fertilizers combined with increasing spacing may be attributed to enhanced growth due to increased supply of plant nutrients and reduced the competition.The current study in line with the finding of Sharma *et al.,* (1990). This could be probably due to the fact that, radish plants grown at wide intra-row spacing are less expose to intra-specific competition for nutrients, moisture and spaces, therefore tended to grow vigorously. High plant populations associated with narrow intra-row spacing tended to exert pressure on scarce growth resources such as light and nutrients there by leading to poor growth.

Leaf number

The interaction effect of Nitrogen and intra row spacing had a significant effect on plant height (Table 1). Leaf number increased linearly in response to increasing the rate of nitrogen fertilizer together with increased intra-row spacing. The lowest leaf number was obtained in the control treatment (0 kg N/ha, 20 cm) which was in statistical equivalence with the leaf number of lettuce all other treatment except the treatment (150 kg N/ha, 30 cm) was maximum number of lettuce leaf obtained. Therefore, it could be argued that nitrogen and wider spacing which enhance lettuce yield thorough promoting leaf number for efficient photosynthesis. The result was revealed that maximum level of nitrogen and plant spacing ensured maximum number of leaves/plant.

Leaf length

The results showed that the interaction effects of nitrogen and intra row spacing was significant on leaf length (Table 1). The lowest leaf length (17.51) was obtained from T3 (0 kg N/ha, 30cm) where as the highest leaf length was obtained from T9 (150 kg N/ha, 30 cm). The result may revealed maximum nitrogen also stimulates branching, increases the number and size of leaves, and reduces leaf senescence, thereby increasing the leaf area and soil cover (Van Burg, 1983).

Leaf width

The results revealed that the interaction effects of nitrogen and intra row spacing was significant on leaf width (Table 1). The highest leaf width / breadth (17.0) obtained from T9 (150 kg N/ha, 30 cm) which was statistically similar with T4 (75 kg N/ha, 20 cm). The lowest leaf width (12.46) was found from T1 (0 kg N/ha, 30cm). This result shows the increase in leaf width of lettuce with increasing the interaction effect of nitrogen rate (0 to 150) and intra-row spacing (2o to 30 cm) irregularly. This study in line with Tisdale *et al., (*1995) who states that nitrogen deficiency symptoms include general stunting, spindly appearance of plants, reduced leaves width, chlorosis and restricted root growth and branching. A deficiency of nitrogen limits cell division and expansion, chloroplast development, chlorophyll concentration and enzyme activity. Nitrogen can influence the leaf area development and maintenance as well as photosynthetic efficiency and dry matter partitioning to reproductive organs (Prystupa *et al*., 2004).

Yield parameter

Yield

The interaction effect of nitrogen and intra-row spacing significantly influence the total yield of lettuce (Table 2).The Results the study showed that highest yield (8.31 t/ha) was recorded from T8 where the lowest (5.96 t/ha) was from T1. Optimum level of nitrogen and plant spacing ensured maximum vegetative growth and ultimate result is to produce the highest yield (Sharma *et al.,*2001).

Table 1. Interaction effect of nitrogen and intra row spacing on plant height, leaf number, leaf length and width of lettuce at 50 days after transplanting growth stages of lettuce crop.

Treatment	Parameter			
	Plant height(cm)	Leaf number	Leaf length(cm)	Leaf width(cm)
T1 (0,20)	19.207c	21.417c	18.707bc	11.2567b
T2 (0,25)	21.783c	25.167cb	18.373bc	12.0400b
T3 (0,30)	25.167ab	27.917b	17.517bc	11.6067b
T4 (75,20)	22.167bc	26.667cb	20.650ba	13.3667ba
T5 (75,25)	20.333c	26.667cb	19.050bac	11.7833b
T6 (75,30)	20.290c	24.917cb	19.583bac	11.7067b
T7 (150,20)	19.333c	23.833cb	18.967bac	11.9667b
T8 (150,25)	19.417c	26.917cb	19.417bac	12.5400b
T9 (150,30)	27.333a	35.917a	21.750a	14.7000a
LSD (5%)	3.23	6.17	2.92	2.11
CV (%)	8.60	13.41	8.73	9.89

Means within a column followed by the same letter (s) are not significantly different at ($p \leq 0.05$).

Table 2. Interaction effect of nitrogen and plant spacing on yield (t/ha) at 50 days after transplanting growth stages of lettuce crop

Treatment	Parameter
	Yield(ton/ha)
T1 (0,20)	5.96ef
T2 (0,25)	7.00cd
T3 (0,30)	6.21e
T4 (75,20)	6.75d
T5 (75,25)	7.34c
T6 (75,30)	7.16c
T7 (150,20)	7.96b
T8 (150,25)	8.31a
T9 (150,30)	7.75b
CV (%)	7.28

CONCLUSION

Generally interaction of nitrogen and spacing had significant effect on growth and yield contributing characters of lettuce crop. Under this study, the vital goal was to achieve highest yield of lettuce cultivation by applying different treatment combinations. This comparably lower yield of the crop in the study area compared to the potential yield could have resulted from the observed poor production season. They were intensive rainfall at day and night, and limitation of solar radiation and temperature which affects the crop physiology besides it affects soil physical and chemical properties may result lower production and productivity.

Therefore, in this experiment farmer in the study area are recommended to applying150 kg N ha^{-1} and 25cm intra row spacing to obtain the highest lettuce yield. However, it is too early to reach a conclusive recommendation since the experiment was conducted only with one variety in one location for one season. Hence, future studies must be done by including the current variety and other improved ones in different agro-ecology and soil type to develop nitrogen fertilizer recommendations with spacing for improving production and productivity of the lettuce crop in Northern Ethiopia so as to enhance household food and nutrition security and cash income of smallholder farmers in the region.

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