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Effect of Inter and Intra-Row Spacing on Yield and Yield Components of Lettuce (*Lactuca Sativa*) in South East Tigray, Ethiopia

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Abstract

Development of recommendation on appropriate plant spacing is one of the important agronomic practices to increase the productivity of lettuce. Therefore, a field experiment was conducted to assess the response of Tesfa Mekelle lettuce variety to different inter and intra row spacing in 2014 cropping season at Illala. The experiment was arranged in a factorial combination of three levels of intra row spacing (30, 40 and 50cm) and two levels of inter row spacing (60 and 70 cm) in randomized complete block design (RCBD) with three replications. The result revealed that plant spacing showed significant effects on leaf number per plant, plant width and fresh biomass yield per hectare. Conversely, the treatment combinations did not significantly affect plant height and leaf length. The highest number of leaves per plant was recorded at 50 x 60 cm intra and inters row spacing and the lowest was obtained from 30 x 60cm intra and inters row spacing respectively. The highest biomass yield (53.6 ton ha^{-1}) was recorded at 40 x 60cm and no further increases was observed when intra spacing increase to 50 cm nor inter row spacing increase up to70cm. The lowest was recorded in spacing 50×70cm. Therefore, it is vital to demonstrate the best treatment (40x60cm) under farmer's conditions.

Keywords: *Lactuca sativa*; Inter and intra spacing; Biomass yield

Introduction

Lettuce (*Lactuca sativa L.*) an annual leafy herb belongs to the family Compositae is one of the most popular salad 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 [1]. It is usually used as salad with tomato, carrot, cucumber or other salad vegetable and often served alone or with dressing. Likewise, in Tigray, Lettuce is an important cash and food security crop for small holder farmers and fresh salad retailers. The lettuce which was grown in the region before was early bolting which is nationally released where farmer use traditional way of planting without distinct inter and intra row spacing.

To date a new lettuce variety was released by the Mekelle Agricultural research center. This variety (Tesfa Mekelle) was the first of its kind and its yield and maturity period are higher and longer and tend to form larger leaves which makes it preferred by farmers for commercial purpose. Successful production of any crop however, requires its own agronomic practices among which plant spacing is one of the factors that can affect vegetable quality and quantity. Optimum plant density ensure plants to grow uniformly and properly through efficient utilization of moisture, nutrients and light resulted in maximum yield of lettuce [2]. Nevertheless, information on plant population has been limited for lettuce production particular for the newly released variety. Therefore, this study was initiated with the objective of assessing the effect of different intra and inter-row spacing on growth and yield of the newly released lettuce variety.

Materials and Methods

Description of the Experimental Site: The experiments were carried out at Illala which is geographically located in the south east of Tigray found at elevation of 1970 meters above sea level at 250 5 'N Latitude and 390 6 ' longitudes. The average minimum and maximum temperature for the aforementioned growing season was 11.1 oC and maximum temperature was 26.5 oC.

Experimental Design and Treatments: The study was conducted in 2014 cropping seasons. The experiment was arranged in a factorial combination of three levels of intra row spacing (30, 40 and 50cm) and two levels of inter row spacing (60 and 70 cm) in randomized complete block design (RCBD) with three replications.

Experimental Procedures: Prior to planting, surface (0-20 cm) soil samples from twelve spots across the experimental field were collected in a zigzag pattern, composted and analyzed at Mekelle soil laboratory research center for pH, texture, soil OC, total N and available P using the standard laboratory procedure to determine the initial soil characteristics of the experimental site. The improved lettuce variety Tesfa mekelle was sown in the nursery and the seedlings were transplanted at 5-6 leaf stage towel prepared beds in the field. Fertilizer was applied at the recommended rate and the field was irrigated every week to meet the water requirement of the crop. All agronomic management practices were done as per the recommendation.

Data Collection and Measurements:

i. **Plant Height:** The height of the main plant was determined by measuring from the border of the soil to the top of the main plant stem.

ii. **Number of Leaf per Plant:** It was determined by counting the healthy leaf by selecting four plants randomly from each treatment and average leaf number was taken.

iii. **Leaf Width:** It was measured by selecting four plants randomly from each treatment and the average leaves width was taken in cm by measuring the width at the middle part of the leaves (at widest part of the leaves)

iv. **Fresh Leaf Weight:** The average fresh biomass yield was measured by selecting four plants randomly from each treatment by uprooting them from the ground and remove the soil from the root part of plant loose soil and weigh immediately.

Data Analysis: All data were subjected to analysis of variance following statistical procedures of SAS software program version 9.2 (SAS institute, 2003). Whenever treatment effects were significant, the means were separated using the least significant difference (LSD) and LSD fisher procedures at the probability level of($p < 0.05$)

Result and Discussions

Soil Physico-Chemical Properties: The selected physico-chemical properties of the soil of the experimental site are shown in Table 1. The soil of the study area is Vertisol with a clay texture [3] with a particle size distribution of 40% clay, 35% silt, and 25% sand. High clay content may indicate the better water and nutrient holding capacity of the soil in the experimental site. The soil reaction is slightly neutral according to the rating of Tekalign [4-6], indicating that it is suitable for growing most crops. Based on the limit set by Hazelton and Murphy [7,8], the soil has high CEC. The data further revealed that the soil is low in available P [9] and low in total N content and organic matter [4], indicating that the native nitrogen and phosphorus contents of the soil are inadequate for optimum growth of crops, which also seriously constrains the production of lettuce. Therefore, the soils need fertilizer amendment for successful lettuce production. The soil falls in the category of non-saline soils according to the rating of Hazelton and Murphy [7] (Table 1).

Table 1: Selected physical and chemical properties of the soil of the experimental site, Illala, Tigray.

Soil property	Value	Rating	References
Sand (%)	25	-	-
Silt (%)	35	-	-
Clay (%)	40	-	-
Textural class		Clayey	Rowell [3]
pH water (1:2.5.H2O)	7.18	Neutral	Tekalign [4]
Organic matter (%)	1.06	Low	Tekalign [4]
Total N (%)	0.09	Low	Tekalign [4]
Olsen-Extractable P(mg/kg)	4.20	Very low	Cottenie [9]
CEC (cmolc(+) kg^{-1})	37.00	High	Hazelton and Murphy [7]
EC(dSm^{-1})	0.48	Non-saline	Hazelton and Murphy [7]

Table 2: The effects of intra and inter row spacing on agronomic trait of lettuce, Illala, Tigray.

Treatment	Stand count ha^{-1}	Plant height (cm)	Leaf width (cm)	leaf length (cm)	Leaf number per plant	Fresh yield t ha^{-1}
30cm x60cm	54783a	27.03a	12.50d	21.83a	70.33c	43.73b
40cm x60cm	54483a	26.10a	13.27bcd	20.87a	79.67bc	53.63a
50cm x60cm	40573b	28.27a	13.60bc	20.77a	99.67a	31.56c
30cm x70cm	33200c	25.87a	13.7abc	20.70a	83.00bc	31.09c
40cm x70cm	24999d	27.97a	14.50ab	21.00a	87.33ab	30.00c
50cm x70cm	24669d	27.03a	14.77a	20.60a	94.33ab	23.45c
CV%	4.2	7.2	8.7	4.9	9.4	12.8

Means of the same parameter in a column followed by the same letter are not significantly different at P= 0.05 according to LSD Fishers Protected.

Effect of Inter and Intra Row Spacing On Plant Height and Leaf Length: Data in Table 2 indicated that plant height and leaf length was not significantly influenced by the planting density.

Effect of Inter and Intra Row Spacing On Leaf Number/ Plant: Leaf number responded significantly (P<0.01) to intra and inter row spacing. Leaf number increased as the intra row spacing increased. The highest number of leaves per plant was recorded from 50x60 cm. Increasing intra spacing from 30 to 50 cm significantly increased leaf number per plant. When the inter row spacing was kept constant at 60cm leaf number per plant increased by about 41% and 24% compared to 30cm and 40cm intra row spacing respectively. However, when the interspacing was kept constant at 70cm increasing spacing from 30 to 50 cm did not significantly increased leaf number per plant. This indicates that interspacing beyond 60 cm have no value as the highest is achieved under 60cm inter row spacing treatment.

Effect of Inter and Intra Row Spacing on Leaf Width per Plant: Leaf width of lettuce was significantly (P<0.01) varied in response to plant spacing. The highest leaf width was recorded from the wider spacing (50 x 70 cm) as compared to the closer spacing (30 x60 cm). However, in spite of the highest width total biomass yield was the lowest attributed to the less plant population.

Effect of Inter and Intra Row Spacing on Fresh Yield: Fresh yield of lettuce responded significantly (P<0.01) to the effects of different spacing. Fresh yield of lettuce was the highest (53.6 ton ha-1) in 40×60cm spacing with 23 % yield increment over plants spaced in 30x60 cm and yield decreased further when intra spacing increase to 50x60cm. These results are in agreement with Donald (1963) who also reported that as plant population increases yield also increases proportionally then decreases after it reaches a certain level. The significant increase in fresh yield in response to 40 x 60 cm spacing might be attributed to the optimum plant density per unit area of land. Concomitant with the results of this study, higher yields in response to closer spacing over wider spacing was reported by Moniruzzaman [10,11]. The low yield under 30cm intra spacing could be attributed to less spacing for each plant so the plant does not acquire optimum space for growth due to intra plant competition for light and nutrition. Similar results were reported in carrot Mengistu and Yamoah [12]. Keeping the inter spacing at 70cm and increasing the intra spacing subsequently decreased the biomass yield progressively which might be attributed to insufficient utilization of the growth factors. Hence, the wider spacing 50cm x 70cm gave the lowest yield. These results agree with Firoz et al. [2] who stated that improper plant spacing may cause either too dense or too sparse population resulting in the reduction of lettuce yield [13] (Table 2).

Conclusion

The results of the present study revealed that intra and inter row spacing markedly affected biomass yield, leaf number and leaf width of lettuce. Intra and inter row spacing of 40x60 cm was found to produce highest biomass yield. Keeping inter row spacing at 60cm, intra spacing beyond 40cm decrease yield due to low plant density whilst, intra row spacing below 40cm decrease yield due to plant competition for light, water, nutrition and other growth requirements. Keeping the inter row spacing at 70cm constant all intra row spacing recorded the lowest biomass yield as compared to 60cm inter row spacing at all intra spacing . Therefore, it could be recommended that lettuce plants should be grown in 40×60cm intra and inter row spacing. It is however, suggested to further evaluate the best treatment across a wider range of agro-ecological zones [14-16].

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