

Adaptability of Lettuce (*Lactuca sativa* L.) Varieties in South Gondar, Ethiopia

Dejen Bekis Fentie^{1,*}, Awoke Ali Zeleke², Birehanu Habete Zegeye²

¹Department of Plant Breeding, Ethiopian Institute of Agricultural Research, Fogera National Rice Research and Training Center, Woreta, Ethiopia

²Department of Horticulture, Ethiopian Institute of Agricultural Research, Fogera National Rice Research and Training Center, Woreta, Ethiopia

Email address:

djbks21@gmail.com (Dejen Bekis Fentie)

*Corresponding author

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Abstract: Lettuce (*Lactuca sativa* L.) is one of the most popular salad crops and occupies the largest production area among salad crops in the world. However, production of lettuce can be limited due to lack of improved varieties for different agro-ecologies. Adaptable high yielder released lettuce varieties were not identified for farmers of Fogera and Libokemkem districts in Northwestern Ethiopia. A field study was conducted at Fogera and Libokemkem districts in 2020 and 2021 to evaluate the yield and yield components of released lettuce varieties at rain fed condition. Two lettuce varieties were used as a treatment viz: RSK-3 and Tesfa. The treatments were laid out in Randomized Complete Block Design (RCBD) with three replications. The analysis of variance revealed that there was a highly significant difference ($P < 0.01$) between locations on stand count, head diameter, leaf length, number of leaves per plant and fresh leaves yield of lettuce varieties. The highest yield was recorded from Tesfa variety at both locations. The higher leaf yield of Tesfa (34.15 ton/ha) and RSK-3(26.8ton/ha) was obtained at Libokemkem than Fogera district Tesfa (3.89ton/ha) and RSK-3(3.67ton/ha). Therefore, Tesfa variety of lettuce could be recommended for both Fogera and Libokemkem districts.

Keywords: Adaptability, Lettuce, Location, Variety, Yield

1. Introduction

Lettuce (*Lactuca sativa* L.) is one of the most popular salad crops in the group of leafy vegetables with the largest production area coverage among salad crops in the world [11]. The genus *Lactuca* L. is an annual leafy herb belongs to the family Asteraceae (Compositae), the largest of the dicotyledonous families [3].

Lettuce is native to the Mediterranean area and Asia Minor, while it was domesticated in the shores of Egypt around 4500 B.C. [12]. However, the greatest species diversity can be found in the Mediterranean basin and Southwest Asia [10]. Lettuce is produced commercially in many countries and is also widely grown as a vegetable in home gardens [9]. The main producers of lettuce in the world are the USA, Spain, Italy, Japan and, France [8].

Lettuce can grow in a variety of soil types and climatic conditions. However, it is extremely sensitive to drought due to shallow root system. It is best grown in silt loams and sandy soils as these soil types provide better drainage and warm up more readily during the day, which is especially important during cooler periods of the growing season [9].

Lettuce is ranked 26th among vegetables and fruits in terms of nutritive value and 4th in terms of Consumption [14]. Lettuce is rich in vitamin A and minerals like calcium and iron. It also contains protein, carbohydrate and vitamin C. In 100g of edible portion of lettuce contains 93.4g moisture, 2.1g protein, 0.3g fat, 1.2g minerals, 0.5g fiber, 2.5g carbohydrates, 310mg calcium, 80mg phosphorus, 2.6mg iron, 1650 I.U. vitamin A, 0.09mg thiamine, 0.13mg riboflavin and about 10.0 mg vitamin C [6]. Also, the nutritional components in lettuce are associated with the reduction in the risk of cardiovascular diseases and certain cancers [1, 7].

Lettuce is one of the major leafy vegetable crops produced for local consumption in Ethiopia. It is extensively grown in most parts of Ethiopia on diverse ecology [14]. Farmers of Fogera and Libokemkem also produced unknown low yielder and diseases susceptible lettuce cultivars. The demand of lettuce is also gradually increasing but relatively only a few farmers are involved with a little lettuce crop production due to the lack of high-yielding and good quality cultivars. There is no investigations have been done so far to improve production and productivity of lettuce in the study areas. In this area, farmers need diseases resistant adaptable high yielder lettuce variety. Hence, identification of adaptable high yielder lettuce varieties is highly important for the study areas. Therefore, the major objective of this study was to identify adaptable high yielder improved lettuce variety/ies and recommended a suitable one for farmers of Fogera and Libokemkem districts in Northwestern Ethiopia and areas of similar agro-ecologies.

2. Materials and Methods

2.1. Description of the Study Area

Field experiment was conducted in the North-Western part of Ethiopia at farmer's land of Libokemkem district from June to September in 2020 and at research station of Fogera National Rice Research and Training Center (FNRRTC) from June to September in 2020 and 2021 under rain-fed condition. Experimental site at Libokemkem is found at 12° 08' N and 37° 07' E with altitude of 1844m above sea level. Whereas, FNRRTC is located at 11°58' N, 37° 41' E and at 1810 m above sea level in Amhara Regional state, Ethiopia. According to the average meteorological data, the annual rainfall, average air temperatures and soil type of Libokemkem (1200mm, 19.5°C and clay loam) whereas Fogera (1300mm, 18.3°C and black *Vertisol*) respectively [2, 4].

2.2. Experimental Material and Experimental Design

Tesfa and RSK-3 lettuce varieties obtained from Holeta Agricultural Research Center were used in this study. The experiment was laid out in a randomized complete block design with three replications at Fogera and Libokemkem districts. Spacing of 30 cm between plants and 40cm between rows were

used with plot size of 3m length and 3.2m width. The path between blocks and plots were 1m and 0.5m, respectively. Seeds were sown on nursery bed at FNRRTC research station and seedlings at 5-6 leaf stages were transplanted on the selected research field of Fogera and Libokemkem district. Dead plants were replaced within a week after transplanting. All experimental plots were fertilized by NPS and urea form with 38 kg ha⁻¹ of P₂O₅ and 7 kg ha⁻¹ of sulfur (S) at transplanting and 88 kg ha⁻¹ of nitrogen fertilizer in splits, half applied at transplanting and the rest half applied at three weeks after transplanting. All other crop management practices such as weeding, and cultivation were applied uniformly as the required.

2.3. Data Collection

Growth and yield parameters were collected at research field by sampling five randomly selected plants from central six rows of each plot. Data on stand count at harvest, plant height, leaf number, leaf length, leaf width, head-diameter and fresh vegetative yield were recorded.

2.4. Statistical Analysis

The averages of the collected data were subjected to analysis of variance (ANOVA) to evaluate the difference of varieties, the varieties response to different locations and their interaction effect as the procedures stated for randomized block design by Gomez, K. A. et al. [5] using Statistical Analysis System (SAS) version 9 software package and least significant difference (LSD) was used to separate means at 0.05 and 0.01 probability levels of significance [13].

3. Result and Discussions

3.1. Analysis of Variance

The analysis of variance for yield and other agronomic characters is presented in Table 1. All studied traits showed a significant difference between locations. Leaf width showed a significant difference between varieties. However, there is no significant difference between the varieties on the remaining growth and yield component parameters. And also, there is no significant difference between varieties with locations interactions.

Table 1. Combined analysis of variance for yield and yield related traits of lettuce varieties tested on two locations (Fogera and Libokemkem) at rain-fed condition in 2020.

Mean Square							
Traits	Rep (df=2)	Variety (df=1)	Location (df=1)	Variety*Location (df=1)	Residuals (df=6)	R-square	CV
Stc	50.08	30.08	2214.08**	154.08	141.42	0.75	17.73
PH	3.57	33.28	200.49*	1.32	23.11	0.64	18.01
HD	14.54	1.52	1655.18**	29.24	33.80	0.89	22.95
LL	6.83	22.14	22.14*	1.97	9.31	0.68	14.94
LW	14.56	32.56*	144.44**	9.36	5.39	0.87	20.37
LNP	62.23	5.56	1363.20**	0.19	48.06	0.84	24.87
YLD	23.40	42.92	2138.62**	38.21	35.77	0.91	34.92

* and **= significance levels of p-value at 5% and 1%, respectively, Stc: Stand count at harvest, PH: Plant height (cm), HD: Head diameter (cm), LL: Leaf length (cm), LW: Leaf width (cm), LNP: Number of leaves per plant, YLD: Fresh vegetative yield of lettuce per hectare (tons).

3.2. Mean Performance of Lettuce Varieties for Yield and Yield Attributed Characters

Plant height is the main factors in determining the yield performance of lettuce. Plant height ranged from 21.28cm to 32.78cm with a mean of 26.7cm. The analysis of variance showed that location had significance influence on plant height (Table 1). Significantly higher (32.78cm) plant height was obtained at RSK-3 variety from Libokmekem district. While, significantly lower (21.28cm) plant height was obtained from tesfa variety at Fogera site (Table 2). Lita B. Cera Lita studied on lettuce and measured plant height at 30 days from transplanting that obtained mean value of 18.52cm [15]. The analysis of variance revealed that there was significant difference ($P < 0.01$) between locations on head diameter of lettuce varieties (Table 1). The highest head diameter (38.28cm) was obtained from RSK-3 at Libokmekem district whereas the lowest (15.5cm) was obtained from Tesfa variety at Fogera district with the mean value of 25.33cm (Table 2).

Leaf length is influenced significantly by location at ($P \leq 0.05$) (Table 1). The maximum leaf length (24cm) was recorded from Tesfa variety at Libokmekem district and the minimum value 16.03cm was obtained from RSK-3 variety at Fogera location (Table 2). Similarly, Lita B. Cera studied in Philiphines on lettuce and the highest leaf length was 17.33cm at the age of 30 days after transplanting [15]. Bewuket and Shewaye at Gurage zone in Ethiopia found that leaf length was ranged from 11.06 to 23.12cm. Leaf width also influenced significantly by variation of location and variety [16]. In the same manner, the shortest leaf width (7.17cm) was observed on the variety RSK-3 at Fogera and the maximum value of leaf width (17.40cm) was recorded on Tesfa variety at Libokmekem site with the mean value of 11.4cm. Similarly, Januka *et al.* [8] in Nepal found that leaf

length and leaf width had showed a highly significant difference between locations and variety with the value of leaf length ranged from 14-25cm whereas leaf width ranged from 13-20cm. Bewuket and Shewaye obtained the maximum leaf width of 11.22 cm from the variety named “Great Lake” at Wulkite university research site in Southern part of Ethiopia [16].

Locations had showed a significant variation in the average number of leaves per plant (Table 1). The average of number of leaves per plant in lettuce varies from 16.67cm to 39.34cm. The maximum value of leaves number per plant was recorded from Tesfa variety at Libokmekem whereas the lowest value was obtained from RSK-3 at Fogera (Table 2).

The analysis of variance for yield and yield related traits in lettuce that tested at Libokmekem and Fogera districts revealed significant varietal difference for fresh leaves yield (Table 1). The highest yield was recorded from Tesfa variety at both locations. The higher leaf yield of Tesfa (34.15 ton / ha) and RSK-3 (26.8ton / ha) was obtained at Libokmekem than Fogera district Tesfa (3.89 ton / ha) and RSK-3 (3.67ton/ha) (Table 2). Generally, all studied traits at Libokmekem district showed a higher value than at Fogera district. This indicates that swampy area similar to Fogera rice growers’ land couldn’t preferable for large scale production of lettuce in the main cropping season. According to variety selection, Tesfa variety is performed better from both Fogera and Libokmekem districts. Luchia *et al.* [11] also studied on lettuce varieties in Southeastern part of Tigray and found that improved Tesfa lettuce variety had good acceptance by farmers with its quality, yield, late flowering or slow bolting and high market acceptability. Bewuket and Shewaye found lettuce yield of 9.45 ton/ha at Gurage zone in Ethiopia [16].



Figure 1. Field performance of lettuce varieties at Libokmekem district

Table 2. Combined mean of growth, yield and yield related parameters of lettuce varieties from two tested locations (Fogera and Libokmekem) in 2020 rainy season.

Location	Variety	Stc	PH	HD	LL	LW	LNP	YLD
Libokmekem	Tesfa	82.67a	28.79ab	35.87a	24.00a	17.40a	39.34a	34.15a
	RSK-3	78.67ab	32.78a	38.28a	22.10ab	12.34b	37.73a	26.80a
Fogera	Tesfa	48.33c	21.28b	15.5b	19.56ab	8.70bc	17.78b	3.89b
	RSK-3	58.67bc	23.94ab	11.67b	16.03b	7.17c	16.67b	3.67b
Mean	Tesfa	65.5	25.04	25.69	21.78	13.05	28.56	19.02
	RSK-3	68.67	28.36	24.98	19.07	9.76	27.20	15.24
Overall mean	Mean	67.08	26.70	25.33	20.42	11.40	27.88	17.13
	LSD	23.76	9.60	11.62	6.10	4.634	13.85	11.95

Stc: Stand count at harvest, PH: Plant height (cm), HD: Head diameter (cm), LL: Leaf length (cm), LW: Leaf width (cm), LNP: Number of leaves per plant, YLD: Fresh vegetative yield of lettuce per hectare (tons).

Most yield and yield related traits of each variety showed a non-significant difference between the year 2020 and 2021 at Fogera (Table 3). However, leaf length, leaf width, number of leaves per plant from tesfa variety showed a significant

difference between the seasons. While, only head diameter and leaf length were showed a significant difference from RSK-3 lettuce variety.

Table 3. Combined mean of growth, yield and yield related parameters of lettuce varieties from two tested rainy seasons of 2020 and 2021 at Fogera district.

Variety	Year	Stc	PH	HD	LL	LW	LNP	YLD
Tesfa	2020	48.33ab	21.28a	15.50ab	19.55a	8.69a	17.78a	3.88a
	2021	28.67b	20.90	17.40ab	14.23bc	6.45b	9.00b	3.65a
RSK-3	2020	58.67a	23.95a	11.67b	16.03ab	7.17ab	16.67a	3.67a
	2021	36.67ab	24.70a	23.35a	12.06c	7.90ab	10.47ab	4.80a
Mean	2020	53.50	22.614	13.59	17.79	7.93	17.23	3.78
	2021	32.67	22.8	20.38	13.15	7.18	9.74	4.23
Overall mean	Mean	43.08	22.71	16.98	15.47	7.56	13.48	4.00
	LSD	22.74	5.54	9.62	3.88	2.13	7.33	5.04

Stc: Stand count at harvest, PH: Plant height (cm), HD: Head diameter (cm), LL: Leaf length (cm), LW: Leaf width (cm), LNP: Number of leaves per plant, YLD: Fresh vegetative yield of lettuce per hectare (tons).

Seeds of Tesfa and RSK-3 varieties were maintained and multiplied at Fogera National Rice Research and Training Center (FNRRTC) research station by isolation distance for

end user farmers and researchers for promotion and future extra investigation works.



Figure 2. Field performance during seed maintenance of lettuce varieties at Fogera National Rice Research and Training Center (FNRRTC) research field station.

4. Conclusion and Recommendation

Location had showed a highly significant difference for stand count, head diameter, leaf length, number of leaves per plant and fresh vegetative yield of lettuce varieties. The highest value for leaf length (24cm), leaf width (17.4cm), number of leaves per plant (39.34) and fresh leaves yield (34.15t/ha) was recorded from Tesfa variety at Libokemkem district. Whereas, the lowest value for leaf length (16.03cm), leaf width (7.17cm), number of leaves per plant (16.67) and fresh leaves yield (3.67t/ha) was recorded from RSK-3 variety at Fogera. The highest yield was recorded from Tesfa variety at both locations. The study concludes that Tesfa lettuce variety performed better as this had showed large in head diameter, longer leaf length and width with more number of leaves per plant that subsequently provided highest fresh leaves yield of lettuce. Therefore, it could be concluded that Tesfa variety might be recommended for farmers and growers of lettuce in the study areas.

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ORCID

0000-0003-1571-4164 (Dejen Bekis)

Conflicts of Interest

The authors declare no conflicts of interest.

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